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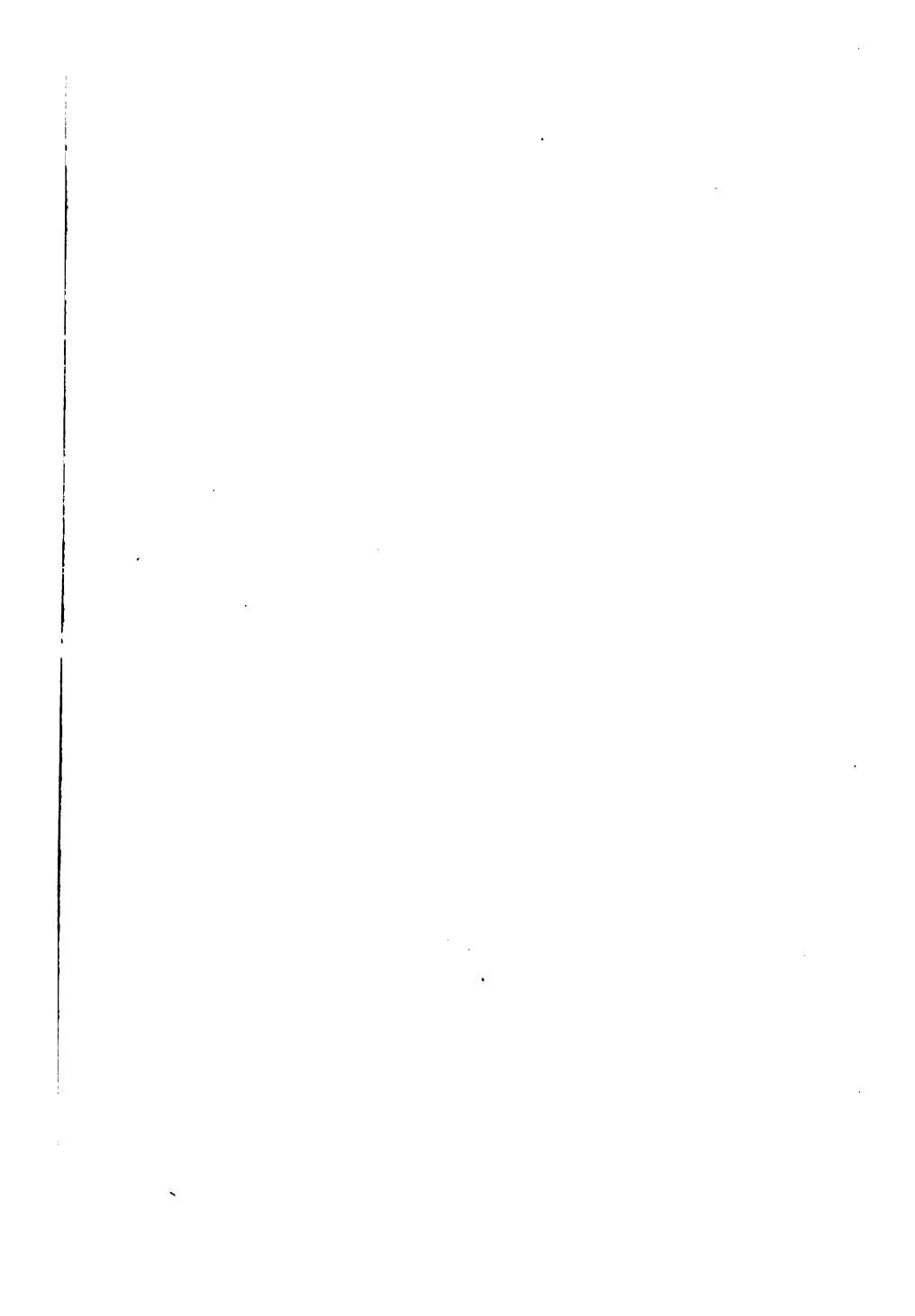
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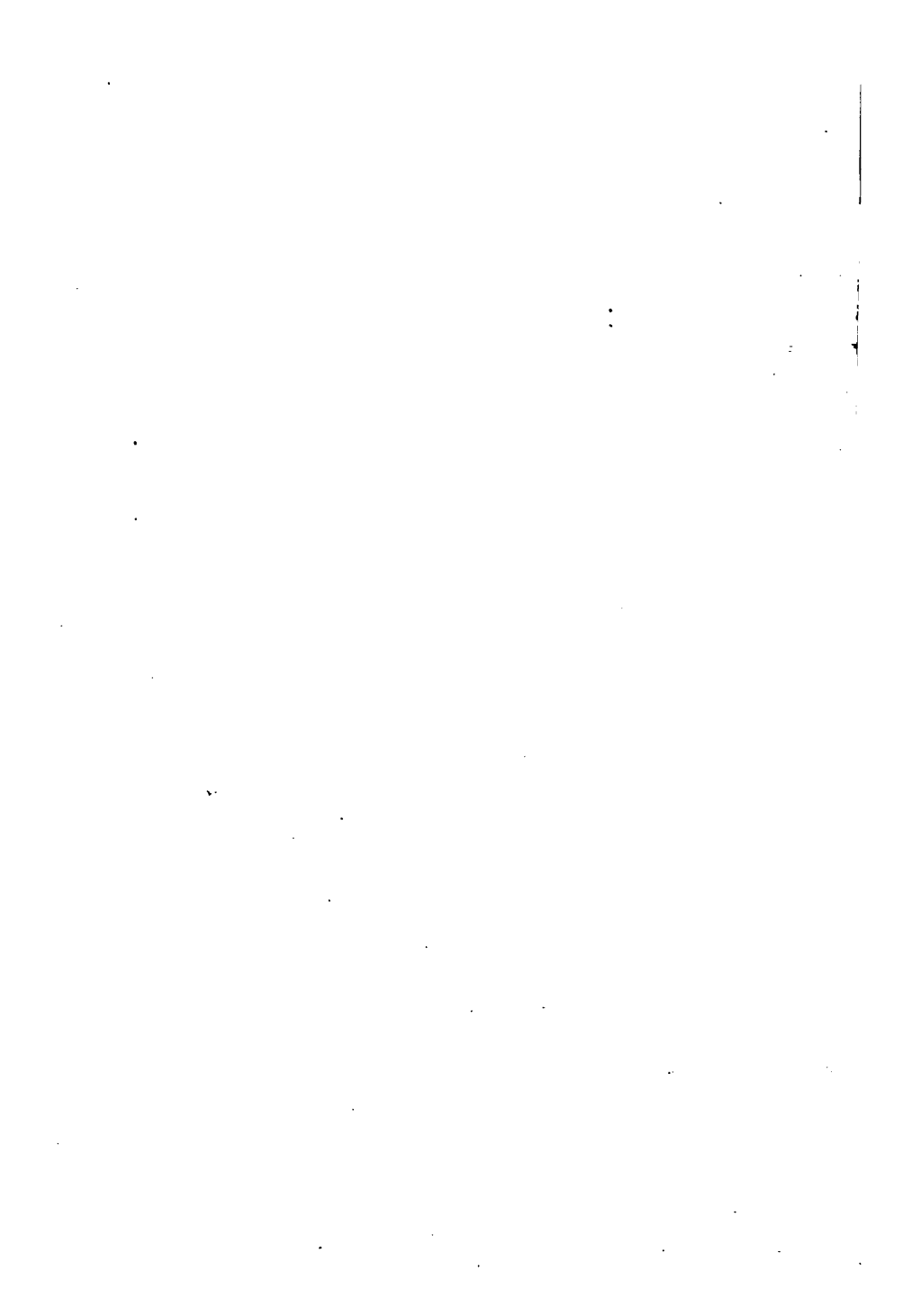


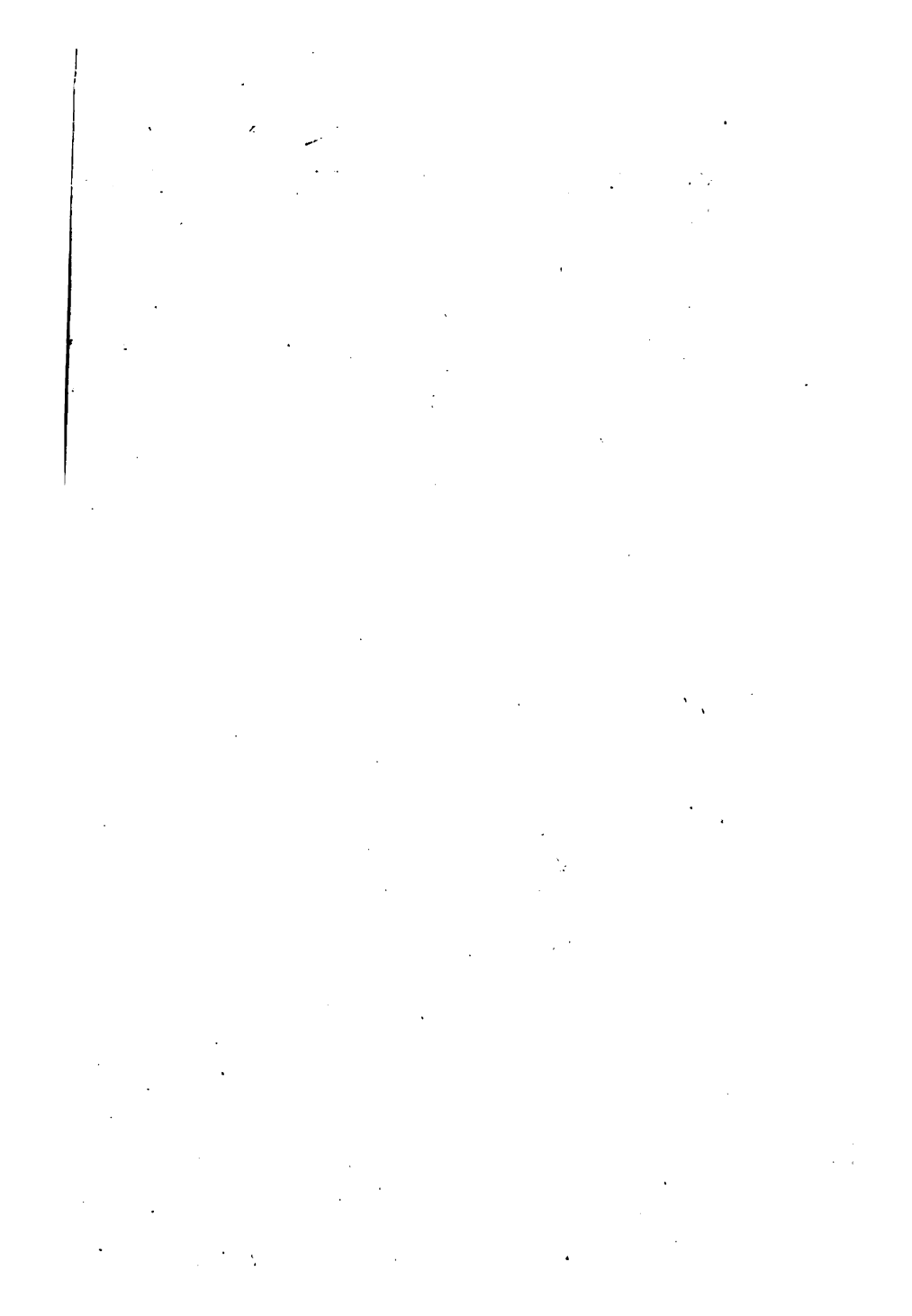
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A CLEAN BARN



CLEAN MILKMEN



CLEAN BOTTLES

WHOLESOME MILK MEANS CLEAN MILK

° GENERAL HYGIENE

BY

FRANK OVERTON, A.M., M.D.

AUTHOR OF "APPLIED PHYSIOLOGY"



NEW YORK :: CINCINNATI :: CHICAGO
AMERICAN BOOK COMPANY

Edue T 399.13.665
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E. P. I

PREFACE

THE personal welfare of each individual depends largely on the efficiency of his bodily machinery. The effects of mental and moral habits on the health of the body have long been known, but the recognition of the effects of bodily health upon the mind and the moral character is of recent date. Bodily health is readily within the control of either the individual himself or his parents. The modern science of hygiene and sanitation is founded upon the idea of personal responsibility of each individual for both the transmission and the acquisition of most diseases.

The experiences of sailors and of explorers in uninhabited lands prove that a small number of healthy persons, separated from the rest of their fellows, and moving from place to place, will be remarkably free from diseases and infirmities in spite of hardships and exposure. The preservation of the same degree of healthfulness in the midst of crowded communities is one of the greatest problems of modern life; and it will be solved only when every person acquires a knowledge of the elementary principles of modern hygiene and sanitation.

This is a textbook on the general subjects of hygiene and sanitation. It is adapted for pupils in

the intermediate grades. It fulfills the requirements of modern courses of study in physiology, and also conforms to the laws of the states requiring instruction in sanitation and in the prevention of diseases. It is also a textbook on anatomy and physiology, but all the topics discussed have a practical application to everyday living. The subjects are presented from the point of view of a health officer on active duty among all classes of people, rather than that of a science teacher whose activities are confined to a classroom.

One reason why a knowledge of hygiene is not more widespread is that its literature is usually full of technical terms and scientific phrases that are not intelligible to untrained minds. This book is not a vocabulary of new terms which must be mastered before a knowledge of hygiene may be acquired; but it employs everyday words and understandable English to inspire the reader to live healthfully and to promote the cause of public health.

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GENERAL HYGIENE

CHAPTER I

THE STUDY OF HYGIENE

Body and Mind. — The body is a living machine, and the mind is the engineer that controls it. The body is useless without the mind, and the mind can do nothing except by means of the body. The two must work together. When either one is out of order, the other also suffers.

One of the greatest of all the differences between a man and a tree is that a man has a mind, and a tree has none. A tree grows in the way in which the soil, the weather, and other trees compel it to grow. But a man can use his mind to choose his home, his food, the air which he breathes, and the work which he does. He can avoid those things which will harm his body, and can do those things which will keep it strong and sound. If the body is in good order, we say that it is *healthy*.

The Joy of Health and Strength. — The mind takes delight in directing the actions of a sound body. A healthy boy runs for the fun of running fast, and climbs hills and trees for the pleasure of using his strength. He studies difficult lessons for the joy of thinking, and puts his whole mind to a puzzle for the delight of solving it. He has no pains or other uncomfortable feelings, and he performs all his actions so smoothly and easily that he almost forgets that he has a body.

Most boys and girls do not always feel bright and active, but sometimes they have aches and pains in their bodies, and are too weak to work or play or think. When they feel like this, they are either over-tired or sick.

Is Sickness Necessary? — Men used to think that sickness was necessary. They supposed that diseases were caused by mighty powers in the air or ground, just as storms and earthquakes were caused. They thought that sickness could no more be prevented than rainy days. Now we know that sickness is not often caused by those things which are naturally found in the air or ground. Most forms of sickness come from causes which may readily be prevented, such as dirt, spoiled food, foul air, and wrong eating. A school child can understand how the common forms of sickness are caused, and how they may be prevented.

Progress in Health Matters. — In the United States there are always over a million persons who are sick.

About two hundred thousand doctors are occupied in caring for them. The expenses of the sickness and the value of the time lost by the sick are at least a billion dollars a year. But no one can estimate the suffering and anxiety which are borne by the sick and their friends.

There is not so much sickness among civilized nations now as there was in former days. We know this from a study of the records of deaths, and from the history of epidemics.

1. The death rate of a country is the number of persons dying each year in every thousand inhabitants. The governments of all civilized lands have long been keeping records of all persons who die in those countries. Before the year 1800, about fifty or sixty persons died each year in every thousand inhabitants of England, Germany, and the United States. Now, only sixteen or eighteen persons die in every thousand inhabitants. But in India the death rate is now as high as it was in England a century ago. This is because the people of India are as ignorant of health matters now as the people of England were a century ago.

2. The average age at which persons die in civilized lands is now nearly double the average age at which they died a century ago. The tombs and mummies of ancient Egypt show that the Egyptians died at an average age of about twenty-two years. In the city of Geneva, Switzerland, the average age of persons dying in the year 1600 was twenty-one years; in 1700,

thirty-two years; in 1800, thirty-eight years. Now, the average age of those dying in Geneva is over forty-five years. This is about the average age at which persons die in the United States, England, and Germany. But in India and Russia the average age at death is now about twenty-five years, or about the same as it was in ancient Egypt. The people of those countries which are the most advanced in civilization and knowledge live about twice as long as the people of the less civilized lands.

3. A disease which spreads through a whole town or country is called an *epidemic* or *pestilence*. The people of olden times were always in fear of war and pestilence. Thousands of men were killed each year by useless and cruel wars, but millions of men, women, and children were killed by diseases which are now seldom seen. In England in the fourteenth century, half of the population died from the plague in a single year. One hundred and two English colonists landed at Plymouth, Massachusetts, in December, 1620, and before the next spring fifty-two of them had died from what is supposed to have been typhus fever. In 1879 one tenth of the inhabitants of the Philippine Islands died from cholera. The plague, typhus fever, and cholera are now almost unknown among civilized people, but these diseases still go on in India and other half-civilized lands. Now and then a few cases reach the United States, but the diseases do not spread because great care is taken to check them.

Cause of Epidemics. — The great epidemics of olden times were spread in very simple ways, and could easily have been prevented. The plague was spread by rats and fleas which swarmed over the thatched roofs and mud floors of the huts of the people. About the year 1900 rats from foreign countries brought the plague to San Francisco, but the disease was stopped by making the foundations and cellars of the buildings rat proof, so that the animals could not find hiding places.

Typhus fever spreads among people who are overcrowded. The colonists of Plymouth were badly overcrowded both on their ship and in their houses. They had no proper means of bathing and no way of separating the sick from the well. To-day, there is hardly a place in the United States where people have to live in the way the colonists lived, and therefore typhus fever is almost unknown in this country.

Cholera is spread principally among those who drink impure water. In 1832 an epidemic of cholera broke out in New York, and all the people who could get away from the city left it in terror. At that time the drinking water was drawn from wells which were dug along the edges of the streets, and the water was foul from slops and garbage which were thrown upon the ground. The people were made sick by drinking house slops and sewage. In 1840 pure water was brought to the city through the Croton aqueduct, and since that time the people of New York have not been in real danger of cholera.

These examples are given to show the simple nature of the causes of most diseases, and how they are in our control. It is not nice to have rats in our houses; it is not fashionable to be dirty; and we are ashamed to have a bad odor about our clothes or houses. But the feelings which educated persons have about dirt and bad odors are not founded merely upon style and show. Failure to keep rats and other vermin out of our houses, and failure to keep clean, would mean sickness and death now, just as in olden times. You may prevent a great deal of sickness by doing the simple things which every polite and thoughtful person in a modern town is expected to do.

Diseases of the Present. — Leprosy, plague, typhus fever, and smallpox were formerly extremely common in all civilized lands. Now, they are seldom seen. Yellow fever and malaria have been wiped out of Panama simply by exterminating the mosquitoes from the place. But a great deal still remains to be done. Only about one third of all deaths in the United States are due to old age, and over half are caused by diseases which may easily be prevented. Typhoid fever is still a common disease, and what we call *colds* are extremely common. Consumption is now so common that it is called the *great white plague*, and one tenth of all deaths among white races is due to it. We think it is a terrible thing that one tenth of the people of the Philippine Islands should have died from cholera in 1879, and yet one person in every ten who now live in

the United States will die from consumption, unless a great deal more is done in the near future than in the past to prevent the disease.

Helping Each Other to Keep Well. — You cannot keep well by thinking of yourself alone. You must think of the health of others in order to protect your own health. If you allow some one to catch tonsillitis from you, he may give the disease to a third person, who may give the disease back to you a month or two after you recover from your first sickness.

You will often be soiled with dust from streets over which diseased persons and animals have scattered the germs of sickness. You will often breathe air which the sick have breathed, and will often buy food which has been handled by unhealthy persons. What others do will affect your own health, and what you do will affect the health of other persons. You are only one among thousands of the inhabitants of a town, but the healthfulness of your town will depend on what each separate inhabitant does. When you help others to keep well, you also help yourself to be healthy.

Teaching the Care of Health. — A little child learns a great deal about the care of his body from his parents. When he goes to school, he learns more about its care from his teachers, and from the books which he studies. Later in life he learns from the advice of doctors, from public lectures, and from articles in books, newspapers, and magazines.

Public schools are among the best of all means for

teaching the preservation of health. Most states now have laws that every public school shall teach its pupils how to take care of their bodies, and how to prevent diseases. If all boys and girls will learn to do their part in the promotion of health, the next generation of men and women will be a vigorous, happy race. Colds and consumption will be as rare as leprosy is now. All will live to a ripe old age, and sickness and pain will be almost unknown. No one will feel that life is a burden, but all will feel the joy that comes from health and strength (p. 10).

Hygiene. — The study of keeping the body in good health is called *hygiene*. In it you will study such subjects as bathing, eating, drinking, clothing, breathing, exercise, and sleep.

Hygiene also includes the study of the methods and conditions by which diseases are prevented. It therefore treats of such subjects as the purity of food, the wholesomeness of drinking water, the freshness of the air, and the disposal of sewage.

Anatomy and Physiology. — Before you can understand the care of the body, you must know something about the structure of its living machinery, and how it does its work. The study of the structure of the body is called *anatomy*, and the study of its work and action is called *physiology*. You must study the anatomy and physiology of each part of the body in order to understand the care of that part.

QUESTIONS

What are some of the signs of good health?

What are some of the signs of poor health?

What effect does sickness of the body have upon the mind?

About how many persons in the United States are sick at one time?

About how much money does sickness cost the people of the United States each year?

Give some reasons for thinking that there is less sickness now than formerly.

What is the average death rate in the United States?

What is the average length of life in the United States?

What is an epidemic?

Name some epidemics which used to be common, but are now seldom seen.

What are some of the reasons why deadly epidemics no longer occur?

Name some deadly diseases which are now common.

How does a person protect his own health when he helps others to keep well?

What is hygiene?

What is physiology?

What is anatomy?

What is the object of teaching hygiene in schools?

CHAPTER II

ORGANS AND CELLS

Life and Growth. — The food upon which the body lives has no life, but it becomes living blood, flesh, and bone in the body. After remaining alive for a few days or weeks, the living flesh becomes worn out and is changed back to dead and lifeless forms, and new flesh is formed to take its place.

The constant building up of worn-out parts of the body is what is called *life* and *growth*. Lifeless things change and go to pieces, and cannot build themselves up again. Living things are said to be alive because they build themselves up as fast as they wear out.

Voluntary and Involuntary Actions. — A person can use his mind in thinking, and his body in moving, whenever he wishes to do so. These two kinds of work are directed by the mind, and are called *voluntary* actions.

The actions of growth and repair are only slightly under the control of the mind, and are called *involuntary* actions. These actions go on while a person is asleep even better than they do while he is awake. The same kinds of action go on in a tree, which has no mind at all.

Division of Labor in the Body. — Each action takes place in a particular part of the body, and in no other

part. One part of the body thinks, another prepares food, another supplies air to all the rest of the body, and other parts get rid of the worn-out flesh. A part of the body which has a particular work to do is called an *organ*.

Organs of Digestion. — The act of changing food to forms which living flesh can use is called *digestion*. There are four principal organs of digestion: 1, a bag, called the *stomach*, which receives the food when it is swallowed; 2, a long tube, called the *intestine*, in which the food is dissolved; 3, a mass of flesh, called the *pancreas*, in which a liquid is prepared for dissolving the food; and 4, a large mass of flesh, called the *liver*, in which the food is made a part of the blood.

Organs of Circulation. — Blood carries digested food through all parts of the body, and its flow is called the *circulation*. There are two principal organs of circulation: 1, a

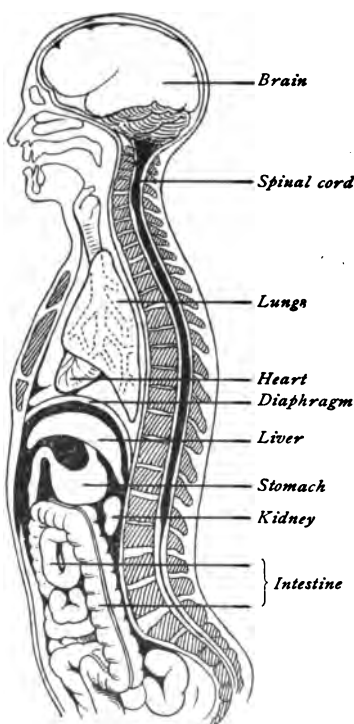


Diagram of the position of the principal organs of the body.

pump, called the *heart*, which keeps the blood in motion; and 2, a vast number of tubes, which conduct the blood through all the flesh and bones.

Organs of Respiration. — The body cannot work, or even live, unless a constant supply of air reaches every part. Taking air into the body, and the changes produced by the air, are called *respiration*. The principal organs of respiration are the *lungs*.

Organs of Excretion. — Getting rid of worn-out substances is called *excretion*. There are two principal organs of excretion: the kidneys and the skin. The lungs, the liver, and the intestine are also important organs of excretion.

Organs of the Nervous System. — All the parts of the body are made to help one another, and to work together, by means of the nervous system. There are three principal organs of the nervous system: 1, the *brain*, situated in the top of the head; 2, the *spinal cord*, situated in the backbone; and 3, long strings of flesh, called *nerves*, which extend from the brain and spinal cord to all parts of the body.

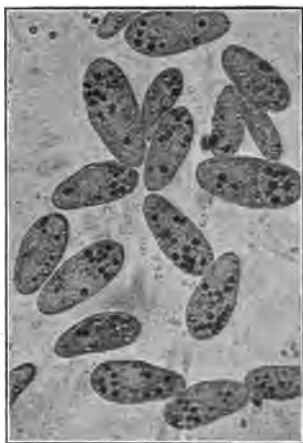
Organs for Voluntary Work. — There are two organs for doing voluntary work: 1, the brain, which does the work of thinking; 2, a large number of bundles of lean meat, called *muscles*, which produce motions. Stiff rods and plates, called *bones*, support the soft flesh and assist the muscles to produce nearly all the voluntary movement of the body.

Cells. — An organ is not like a lump of clay which is

the same throughout its whole mass, but it is made up of microscopic living things called *cells*. All flesh is composed of cells which do their work like separate animals.

Cells in Lower Animals and Plants. — All animals and plants are composed of cells. In the lowest forms of living beings each animal and plant is composed of a

single cell. A common one-celled animal is called the *slipper animalcule*, or *paramecium*. It is microscopic in size, and is found in stagnant water.



Slipper animalcules. *Magnified.*



Threads of pond algæ.
Magnified.

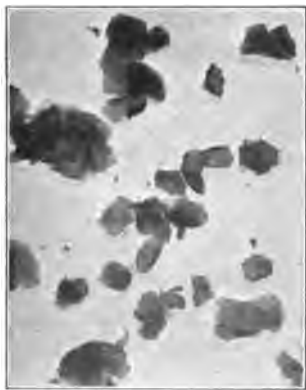
Place a handful of hay or dry grass in a jar of water, and leave the jar in a warm room. After two or three weeks the water will usually contain great numbers of tiny white specks, each of which is a paramecium. If you look at a drop of the water with a microscope, you can see the shape and structure of the animals as they move rapidly through the water.

Collect some of the green, silky

threads which float on still ponds, or grow on sticks and stones in the water. These threads are green plants called *algæ*. Examine a few of the plants under a microscope. Each plant is a thread which consists of a single row of oblong cells joined end to end.

All higher plants and animals, such as wheat or a bird, consist of masses of cells.

Size and Shape of Cells. — The different kinds of cells in the human body vary in size and shape, but not



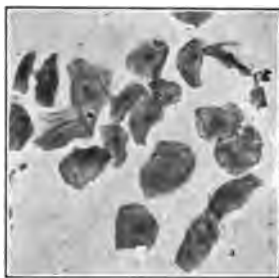
Cells scraped from the back of the hand. *Magnified.*

one of them is large enough to be seen with the naked eye. If you scrape the skin with a knife, you will get a white powder which looks like flour. This powder consists of cells from the outer covering of the skin. If you look at the powder with a microscope, the separate cells appear like flat scales. The largest of these cells measure about one five-hundredth of an inch across.

A muscle cell is shaped like a string, and is about one five-hundredth of an inch in diameter and about one fiftieth of an inch in length. A blood cell is round and almost flat, and measures about one three-thousandth of an inch across. If you put a bit of flesh under a micro-

scope, you can tell from what organ it came by noticing the size, shape, and arrangement of its cells.

How Cells Grow. — Most of the cells of a baby's body are of the same size and shape as the cells of a grown man, but there are not so many of them. A child does not grow by making the cells of its body larger, but by making their number greater.



Cells of epithelium from the mouth.

A cell consists of two parts:

1, a soft jellylike substance, which forms the greater part of the cell; and 2, a darker bit of matter, called the *nucleus*, which is situated near the center of the cell. When a cell reaches full size, its nucleus divides into two parts, and the rest of the cell then splits itself in half between the halves of the nucleus. Thus a young cell is just half the size of a full-grown cell, but it is like a full-grown cell in all other respects.



Connective tissue around muscle cells. *Magnified.*

Connective Tissue. — A group of cells which look and act alike is called a *tissue*. The working cells of every organ are held in place by a tissue called *connective tissue*. These cells are small, and have long,

slender arms which are tough and strong. These arms extend around and between the cells, and hold them in



Beefsteak. Connective tissue around bundles of muscle cells.

place. If you examine the end of a piece of beefsteak, you will find a white network of tough connective tissue lying between red bundles of soft muscle cells. Some connective tissue is found in every part of the body. It forms the greater part of the skin.

Epithelial Tissue. — The whole skin is covered with cells which are like soft scales. These cells are called *epithelial tissue*, or *epithelium*. One of their principal uses is to protect the soft and delicate flesh under them.

Glands. — The skin is always moist with a liquid, called the *sweat*, or *perspiration*. The sweat comes from pores, which are the openings of deep, narrow tubes extending into the skin. Each tube is lined with cells of epithelium, which extend down the tube from the surface of the skin. The use of the cells of epithelium in the tube is to form the sweat or perspiration out of material brought to them by the blood.

A tube composed of cells of epithelium, which form a substance out of the blood, is called a *gland*. The

substance which a gland forms is called a *secretion*. Sweat glands are found in the skin on nearly every part of the body.

The kidneys, liver, and pancreas are glands. They are composed of tubes of epithelium which either manufacture substances for the use of the body, or take waste substances from the blood.

The stomach and intestine contain glands which secrete digestive juices.

Mucous Membrane. — A loose sheet of tissue, which is like thin, soft skin, lines the inside of the nose and

mouth. It also extends down the tubes which supply air and food to the body, and forms a kind of inner skin in the lungs, the stomach, and the intestine. This inner skin is called *mucous membrane*. It is covered with epithelial cells, which are like those on the surface of the skin.

Mucous membrane contains glands which are similar to those on the skin. These glands secrete a slippery liquid, called *mucus*. One of the principal uses of mucus is to protect the mucous membrane.



Glands of the intestine.

Nature of the Processes of Life. — Men used to think that the processes of life were carried on by what they called *vital spirits*, and that sickness was caused by evil spirits which made their home in the sick person's body for a time. Now it is known that the work which goes on in most parts of the body is done by the same means and in the same manner that work is done in a workshop or laboratory. For example, the heat of the body may be measured in the same way as the heat of a bottle of water. Food may be digested in a bottle in the same way that it is digested in the stomach.

There are exact means of knowing the changes which take place in the body, both in health and in disease. The study of physiology has led to the discovery of the causes of most forms of sickness and of the means of keeping the body healthy. You can learn the proper care of your body as readily as you can learn to care for an automobile.

QUESTIONS

Name one great difference between bodies which are living and those which are lifeless.

Name the two principal voluntary actions which take place in the body.

Name some involuntary actions which take place in the body.

What is an organ?

Name the principal organs of digestion; of circulation; of excretion; of the nervous system; of voluntary work; of respiration.

What are cells?

What is the size of cells?

How do cells multiply in number?

Describe an animal which consists of a single cell.

Describe a plant in which cells may be readily seen.

What is a tissue?

What is *connective tissue*?

What is *epithelial tissue*?

What is *mucous membrane*?

Describe a gland.

What is a *secretion*?

Name some glands.

Name some living processes which may be measured and imitated in a laboratory.

CHAPTER III

COMPOSITION OF THE BODY

The Substances in the Body. — The substances of which the body is composed are constantly changing. Over a pound of flesh wears away each day, and new flesh is formed in its place.

The body is composed of five different kinds of substances. Their names are water, minerals, protein, fat, and sugar. It is important for you to remember these five substances and to understand what they are, for every act of the body produces a change in them.

Water. — Water is the most abundant substance in the body. Three fourths of the weight of the flesh, and one fifth of the weight of bone, is water. It does not exist pure and alone by itself in any part of the body, but it is always found mixed with other substances. It does not change the composition of the other substances of the body, but it softens and dissolves them so that the processes of life can go on.

Minerals. — If a person's body were burned, about one twelfth of it would be left as ashes. The ashes are mineral substances which are mixed with the flesh, blood, and bone of every part of the body. The most

abundant of the minerals is lime. Most of the lime is found in the bones, but some is also found in flesh and blood. Salt, soda, potash, and iron are other important minerals which are always found in the body.

Protein. — Protein is a substance which may be found in every living thing. An older name for it is *albumin*. It is formed only by living beings. All life is carried on by means of it, and without it there can be no life. Growing cells consist principally of protein and water, with a little mineral matter. The protein in the body weighs about one eighth as much as the whole body.

Pure protein is a solid substance which is like the dried white of an egg. It does not exist alone and in a pure form in any part of the body, but it is always found dissolved in water and mixed with a little mineral matter. When we speak of the protein of the body we mean a liquid or jellylike mixture of protein, water, and minerals.

The liquid protein of flesh becomes changed to a solid form when it is heated. This change from a liquid to a solid form is called *coagulation*. Examples of the coagulation of protein are the hardening of the white of an egg when it is boiled, the curdling of milk when it sours, and the clotting of blood after it flows from the body.

Fat. — About one tenth of the body consists of fat which is like lard or tallow. Collections of fat lie under the skin, and between the bundles of muscles, and

around the organs of the body. Fat itself is not a living substance, but what is called fat meat consists of tiny pockets of living connective tissue cells filled with fat. The fat of a living body is not solid as it is in cold meat, but during life the heat of the body keeps it in a liquid form.



Fat tissue.

The use of fat is to keep the body warm, and to furnish it with strength to work. When a person cannot eat food, the body uses up its own fat as food. It then loses weight and be-

comes thin. Fat is food stored up to be used when the body cannot get other food.

Sugar. — About eight ounces of substances which are like sugar are found in the liver and muscles. Their use is to supply the body with heat and strength.

Food. — The water, minerals, protein, fat, and sugar of the body come from the food which is eaten. All food consists of these same kinds of substances. The body takes about five or six pounds of them daily, and it must give them off in nearly the same amounts, for its weight changes very slowly. But before getting rid of them, the body changes some of them by a process, called oxidation, which is like the burning in a fire.

Oxygen. — No person can live unless he takes air into his body several times each minute. The part of the air which the body uses is called *oxygen*. This substance forms about one fifth of the whole air. The quantity of oxygen which the body takes from the air each day weighs about twice as much as all its food except water. The oxygen passes through the body with the blood, and joins itself to food and flesh. The process of joining oxygen to another substance is called *oxidation*.

Oxidation in a Fire. — A fire is an example of oxidation. Burning is the process of uniting oxygen with fuel, such as wood, coal, or oil. When wood burns, more than its own weight of oxygen unites with it quickly and forcibly. While the two substances are uniting, they produce a great deal of heat. When the oxygen and the wood are joined together, they become smoke and ashes.

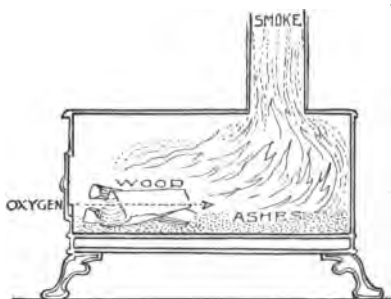


Diagram of oxidation in a stove.

Heat from Oxidation. — Oxidation in the body is the same kind of process as that which takes place when wood burns in a stove, but it takes place slowly and gently in the body. It produces the same quantity of heat that burning the food or flesh in a stove would

have produced. The heat produced by oxidation keeps the body warm.

Power from Oxidation. — Oxidation also gives the body power and strength to do work, just as the burning of wood and coal supplies power to a steam engine. All the strength of the body to walk, or speak, or think, or to do anything else, comes from oxidation. When we say that the body wears itself out by working, we mean that it oxidizes its flesh and food, just as a locomotive engine burns up coal when it runs.

Worn-out Flesh. — The worn-out substances and waste matters of the body are mostly food and flesh which have been oxidized. They are composed of the same kinds of substances that are in the smoke and ashes of a fire.

The protein, fat, and sugar of food and flesh are composed of nearly the same kind of substances of which wood and coal are composed. The names of the two most abundant of these substances are *carbon* and *hydrogen*. The oxidation of these two substances supplies most of the heat and power of the body.

Carbon Dioxide. — Carbon is usually a solid. A common form of it is charcoal. When oxygen unites with it, the two substances become a gas called *carbon dioxide*. This is the same gas that is put into soda water to make it bubble and foam. Carbon dioxide is produced in fires by the oxidation of the carbon of the fuel, and is found in the smoke. It is also produced by the oxidation of the carbon in flesh and food.

If you put one end of a tube into a glass of clear lime-water and blow through the other end, the carbon dioxide from your breath will turn the limewater milky. This is a test by which the presence of carbon dioxide may be known.

Manufacture of Water in the Body. — Free hydrogen is a gas, and is one of the principal substances in the gas which is burned in houses. It is also abundant in wood, coal, and oil, and in a person's flesh and food. When oxygen unites with hydrogen, the two gases become water. When a cold lamp chimney is put upon a lighted lamp, the vapor of water which is formed by the burning hydrogen of the oil may be seen on the inside of the chimney. Nearly a pint of water is formed each day in the body by the oxidation of the hydrogen of food and flesh.

Other Waste Matters of Oxidation. — When food and flesh are oxidized, the minerals are left behind like the ashes of a fire. The oxidation also leaves a small quantity of partly burned substances which are poisonous to the body. Among them are two substances called *urea* and *uric acid*. These two substances are formed during the oxidation of protein.

If the oxidation in the body is disturbed in any way, as by improper eating or breathing, the waste substances will be far more poisonous than the carbon dioxide, urea, and uric acid which are naturally formed. These poisonous waste substances are the cause of much of the pain and weakness during most forms of sickness.

QUESTIONS

- Of what five substances is the body composed ?
How much of the body is water ?
Of what are the ashes of burned flesh composed ?
How much of the body is mineral matter ?
Describe protein. Give an example of protein.
How much of the body is composed of fat ?
How is fat stored in the body ?
How much sugar is found in the body ?
What is *oxygen* ?
What is *oxidation* ?
Describe the process of burning in a fire.
Compare oxidation in the body with a fire.
Of what use is oxidation in the body ?
Of what does worn-out flesh in the body consist ?
What is *carbon* ?
What substance is produced when carbon is oxidized in the body ?
What is *hydrogen* ?
What substance is produced by the oxidation of hydrogen in the body ?
What substances are formed by the oxidation of protein ?

CHAPTER IV

BACTERIA

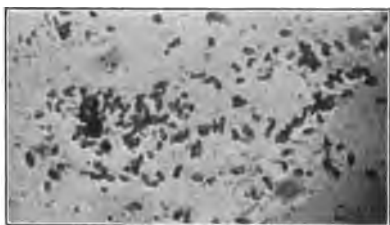
Infectious Diseases. — Diseases and disorders of the body may be divided into two classes. First, there are those forms of sickness which arise from within a person himself. For example, weakness and sickness may be caused by wrong eating or drinking, or by overwork, or by a sad or worried mind, or by lack of exercise.

Second, sickness may be caused by something which enters a person's body and grows there. All diseases which are caught belong to this class, and are called *infectious* diseases. They are caused by living plants or animals called disease germs. The germs enter the body, and there multiply and grow. More than half of the deaths which occur before old age are due to infectious diseases. Nearly all fevers, and what are called colds, are caused by disease germs.

Bacteria. — Germs of disease are the smallest living things that are known. Most of them are plants, and belong to a group called *bacteria*, or *microbes*, just as an oak belongs to a group called trees, and wheat belongs to a group called grass. Each bacterium is a single cell which is smaller than any cell of a human body. It is not divided into distinct parts, such as roots,

branches, and fruit, except that on a few kinds tiny projections, like hairs, may be seen. The separate bacteria cannot be seen without a powerful microscope, and then they seldom appear larger than the tiny dots and dashes of a printed page.

How to see Bacteria. — An easy way to find bacteria is to soak a handful of hay in a bottle of water. After



Bacteria in hay water.

a few days examine a drop of the water with a microscope, using its greatest magnifying power. You will see great numbers of bacteria that appear like faint dots and dashes in constant motion.

How Bacteria Grow. — Bacteria increase in number by the simple process of each one dividing itself into two bacteria, just as if it had been broken in two. Each of the two is as complete and separate a bacterium as the single plant was before it became divided. Within an hour each of the two may reach its full size and may itself divide into two, thus making four bacteria. Each of the four may divide within another hour, making eight. If this goes on for twenty-four hours, there will be sixteen millions of bacteria in place of only one, and yet they are so small that the whole of them would form a lump no larger than a small grain of sand. At the end of two days the bacteria would

multiply to two hundred and fifty-six millions of millions, and would fill a pint measure. At the end of three days there would be enough bacteria to load an ocean steamship. Bacteria often multiply at this rate for a few hours, but they soon use up all the food which they can reach, and their further growth is then impossible.

Where Bacteria are Found. — Since bacteria multiply with great rapidity, they are the most abundant of all living things. Countless millions are found in all kinds of decaying substances, and in the soil. Water usually contains a few of them, and every object is sprinkled with them. About a thousand bacteria are found in each drop of milk when it is fresh and clean, but over a million are found in each drop after it has stood for a day in an ordinary pantry.

Bacteria are the hardest to kill of all living things. Drying or freezing does not kill most of them, but only stops their growth until they become wet or warm again. When dried, they are often blown away by the wind, and so bacteria are found in most dust, and on everything on which dust falls.

Decay. — One of the most common effects caused by bacteria is to destroy substances in which they grow. A living thing preserves itself, but after it dies, it usually becomes soft and finally goes to pieces, unless great pains are taken to preserve it. This natural process of destruction is called *decay*, or *rotting*, and is caused principally by bacteria.

The final result of decay is to oxidize dead matter, and to form the same substances that would have been formed if the decaying matter had been burned. When the process of decay is complete, the oxidized products are in such a form that plants can use them as food, and can build the particles again into living forms. The fertilizers which farmers spread upon their land consist principally of decaying substances.

Decay is as necessary as growth, for if dead animals and plants did not decay, their remains would soon cover the whole earth. Everything that is alive will finally die, and its particles will return to the earth, air, and water. The greater part of the work of destroying lifeless substances that were once alive is done by bacteria.

Molds. — Molds form a class of plants which grow and act much like bacteria. The green furry coating



Mold. Fruit stalks and spore cases.

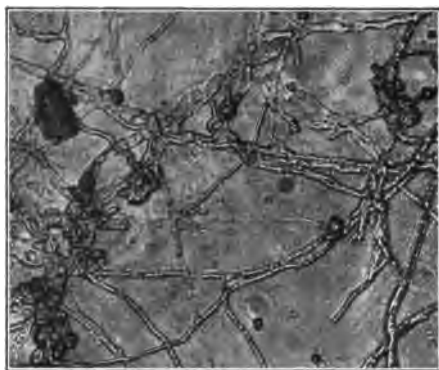
on old bread or cheese is mold, but the fur on their surface is only the fruit of the mold plants. The greater part of a mold plant consists of threads which grow beneath the surface of the food, and are so small that they may scarcely be seen with the naked eye.

Under the microscope, the threads appear like long cells joined end to end into strings. Molds multiply like bacteria, and cause decay in substances in which they grow, just as bacteria do.

Mold Spores. — Many kinds of full-grown mold plants send up tiny stalks, each bearing a knob on its top. The knobs are hollow cases filled with tiny balls called *spores*.

Each spore is a kind of seed which may grow and produce a mold plant.

Mold spores float away in the air, and grow on substances on which they fall. They are scattered everywhere, and so



Mold threads.

molds are found wherever there is a soil to furnish them with food for growth. Molds have an important effect on the health of persons, for they cause food and other substances to spoil and decay, and wherever they grow, bacteria also are likely to be found.

Canning Food. — A substance will not decay if there are no living bacteria or molds in it. We keep food from decaying by boiling it, so as to kill all living bacteria and molds in it. We then seal it in air-tight cans so that no more living germs will enter it. Food

canned or preserved in this way will remain fresh for months or years.

Canned food often spoils because those who put it up do not boil the jars and their covers in order to kill the germs on them. A good way to can fruit is to put it into the jars and put the covers on loosely. Then boil the jars and fruit together, and fasten the covers on tightly.

Useful Bacteria. — Many kinds of bacteria produce substances which are pleasant to the taste or smell, or which are useful to man. Bacteria change cider to vinegar. They are necessary in making butter, for butter made from milk and cream which contains no bacteria tastes about like lard. Farmers depend on bacteria to cause substances to decay and enrich the soil, and cities often depend on bacteria of decay to destroy their sewage. Over a thousand kinds of bacteria are known, and nearly all of them are useful to man.

Ptomaines. — In most decaying matter, substances called *ptomaines* (tō'ma-ins) are formed. Many of the ptomaines are extremely poisonous when they are taken into the body. Food that is sour or spoiled often contains ptomaines which are likely to cause sickness in any one who eats the food. Spoiled food may usually be known by its unpleasant smell and taste, but some of the most dangerous of all the ptomaines have neither taste nor odor, and persons have been poisoned to death by eating spoiled food that smelled and tasted

good. Milk, and foods made from milk, are specially likely to be made poisonous by the growth of bacteria in them.

Bacteria in the Body. — Many kinds of bacteria which produce offensive decay are always growing on the skin. In the mouth bits of food, dead skin, and the moisture of saliva form a good soil in which many kinds of bacteria flourish, causing decay and a bad smelling breath. Bacteria are the cause of decay in teeth. They grow in the dead scales of a dirty skin, and cause the bad odors of an unwashed body. They grow abundantly in the intestine, and are the cause of many forms of indigestion.

A few kinds of bacteria may grow in living flesh. These are the causes of most kinds of infectious diseases.

List of Infectious Diseases. — The common diseases which persons may catch from others who have the same diseases number about twenty. Among those of which bacteria have been proved to be the cause are diphtheria, typhoid fever, tuberculosis, grippe, pneumonia, lockjaw, erysipelas, and most kinds of tonsillitis, colds, and sore throats. Pimples, boils, and all other kinds of sores which give off a creamy matter are



Bacteria which produce pneumonia.

often called blood poisoning, but they are all caused by bacteria growing in the flesh.

Other examples of infectious diseases are mumps and whooping cough, and also those diseases in which the skin becomes spotted or broken out, such as measles, German measles, scarlet fever, smallpox, and chicken pox. They resemble the diseases whose cause has been proved to be bacteria.

Other Kinds of Disease Germs. — A few kinds of infectious diseases are caused by microscopic animals which grow in the blood. Malaria is caused by a microscopic animal which a kind of mosquito leaves under a person's skin when it sucks his blood. Hydrophobia is caused by microscopic animals which grow in the brain.

Where Disease Germs are Found. — Germs of disease do not grow naturally in the soil, or water, or air, or food. Nearly all kinds grow only in the bodies of sick persons or animals, but they may stay alive after they have left the bodies of the persons or animals in which they have grown. If a person has an infectious disease, it is because he has received living germs from some one who was sick before he was. Every person who has an infectious disease is dangerous to others around him, unless great pains is taken to kill all the germs which come from his body.

When a person has an infectious disease, some of the germs may leave his body from sores and wounds, if there are any on the skin; but very few germs leave the

skin when it is clean and sound. Nearly all the germs which leave the body pass off either from the nose or mouth, or from the intestine, or from the kidneys. If every sick person should guard these four gateways of his body, few disease germs would escape 'alive, and soon no one would catch an infectious disease.

Cleanliness. — If disease germs are not caught and killed as soon as they leave the body, they may remain alive for some time. They are found on everything which has been soiled by those who are sick with infectious diseases. They are found in dirt, filth, and garbage; in the dust and foul air of houses and meeting places; on dirty handkerchiefs, towels, bedclothes, and soiled garments; and on forks, spoons, dishes, and other table furniture which have been used by the sick. The prevention of diseases may be summed up in the word *cleanliness*.

By cleanliness we do not mean something hard and difficult which only a doctor can understand, but simply keeping clean in the same way that persons do when they expect company. It also means keeping back yards and kitchens clean and neat.

Board of Health. — Many careful persons do not know how to prevent the spread of disease germs, and many persons who know how are so careless that they endanger the health of the whole population of a town. For example, many persons throw their garbage, slops, and sewage in a heap behind an outbuilding, and then flies and the wind scatter disease germs from it to a

whole neighborhood. In every state and town men are appointed as a *board of health*, whose duty is to compel all persons to prevent the spread of disease germs from themselves and their premises. Among the matters which are in their charge are the disposal of slops, garbage, and sewage, the maintenance of the purity of drinking water and food, and the prevention of the spread of disease germs from those who have dangerous diseases, such as smallpox and diphtheria.

QUESTIONS

What are infectious diseases?

Name some infectious diseases.

By what are infectious diseases caused?

What are *bacteria*?

How large are bacteria?

What do bacteria look like?

Where may bacteria be found?

How do bacteria grow and multiply?

What have bacteria to do with decay or rotting?

Of what use is decay?

Name some other uses of bacteria.

Why does food keep fresh when it is properly canned?

What are *ptomaines*?

What is one of the reasons why spoiled food is sometimes poisonous?

What are *molds*?

What are spores?

On what part of a mold plant do the spores grow?

Why does a piece of bread often become moldy a few days after it is cut?

Where do the bacteria of infectious diseases grow ?

From what part of a sick person's body are disease germs given off ?

What has cleanliness to do with preventing the spread of diseases ?

What has a board of health to do with preventing infectious diseases ?

CHAPTER V

ALCOHOL

Appetites. — Cats, dogs, and other lower animals are able to live healthy lives because they are born with appetites and feelings which they follow in whatever they do. Their feelings of hunger and thirst, of pain and fatigue, of joy and pleasure, and of anger and fear, are some of the guides by which they live and act.

We have the same kind of appetites and feelings that lower animals have, and we take these feelings as our guides in what we do. But we also have our thoughts to guide us. An animal does not think, but it tries to satisfy its appetite as soon as it feels a desire for something. We can think what will happen if we should satisfy an appetite, and we can judge whether or not it is best to do what we feel like doing. We live by means of our thoughts, as well as our feelings.

Pleasure of an Appetite. — Satisfying any appetite gives us pleasure while we are satisfying it. Thus pleasure leads us to supply the needs of our bodies. If eating were a painful duty, many persons would starve to death rather than take food. But eating is a great pleasure, and many persons eat too much because they

think of the pleasure of eating, and forget the needs of their bodies. Appetites are not always sure guides, for they may be false and harmful.

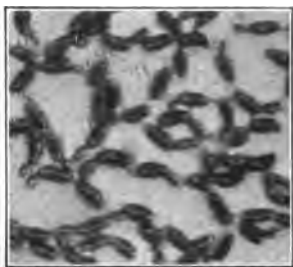
False Appetites. — Some persons have appetites for things which are not good for them. Many poisons seem to give pleasure at first, but they cause sickness a few hours or days after they have been taken. Some of these poisons are alcohol, tobacco, and opium. Many persons have appetites for them, and take them when they know their danger. These appetites are false, but they are often more powerful than the appetites which are true and useful. Men often yield to false appetites because they think only of their present pleasures. It is important for you to know what these false appetites mean; to understand the danger from satisfying them; and to know the means of preventing and overcoming them.

Intemperance. — Satisfying a false appetite is called *intemperance*. A person who eats for pleasure is intemperate in his eating, but by intemperance we usually mean satisfying an appetite for drinks which contain alcohol. These are the drinks which are sold in saloons and barrooms, and which are often called *strong drink*. Men take strong drink because they have an appetite for it, and do not stop to think of the harm that it will do.

There are many kinds of strong drink, but all of them contain a substance called *alcohol*. They are manufactured from liquids which contain sugar, and are

made by changing the sugar to alcohol. This change is produced by means of plants called *yeast*.

Yeast. — Yeast plants are so small that they cannot be seen without a microscope. Each plant is a single



Yeast plants. *Magnified.*

oval cell. A yeast cake that may be bought at a grocery store consists of millions of dried yeast plants mixed with flour or meal. When the cake is placed in water which contains sugar, the cells grow rapidly, and new cells spring from the sides of the old ones

like buds from a twig. In this way the yeast plants increase in number as rapidly as bacteria do (p. 36).

When yeast plants grow, they change sugar to alcohol and carbonic acid gas. The gas rises through the liquid in bubbles which look like bubbles of steam in boiling water. For this reason the change is called *fermentation*, from the Latin word meaning boiling.

Fruit Juice. — The juice which is pressed from sweet fruit contains sugar, coloring matter, and flavorings. After it has stood for a few hours, it begins to ferment. The fermentation is caused by yeast plants which fall into the juice from the air. The yeast changes the sugar to alcohol, and the fruit juice is then called *wine*. Most wine is made from grape juice.

Fresh fruit juice is a wholesome food and drink, for it is fruit from which the skins and tough parts of the

pulp have been taken. If the juice is heated and put into sealed cans or bottles, it may be kept for months and years without fermenting, just as canned food is kept (p. 39). In this way fresh grape juice, called unfermented wine, is preserved.

Wine. — There are many kinds of fermented wine, but all kinds have alcohol in them. Some are only 5 per cent alcohol. The strongest wine which may be made by fermentation contains about 12 per cent of alcohol. Alcohol is added to some wines, such as Port wine, and these contain about 20 per cent of alcohol. Men use wine for the sake of the alcohol which is in it.

Wine was the only strong drink that men had in olden times. They knew that grapes were good food, and they used grape juice as a drink. They noticed that fermented juice seemed stronger, and had a quicker and more powerful effect, than fresh juice. They also knew that many persons became poisoned by drinking the fermented juice, while the fresh juice was harmless. But men did not know that the difference was due principally to the alcohol in the fermented juice.

Some persons suppose that home-made wine will not contain alcohol if no alcohol is put into it. Every drink which is made by fermentation contains alcohol. Home-made wines contain alcohol, and are as harmful as those which are bought.

Cider. — Wine made from apple juice is called *cider*. Apple juice begins to ferment within a few hours after

it is pressed out, and cider which is only a few days old will contain enough alcohol to be harmful.

Vinegar. — If a fruit juice contains only a little sugar, it will become sour when it ferments. This is because bacteria grow in the juice with the yeast, and change its alcohol to a sour substance called *acetic acid*. After cider has fermented for some weeks, all of its alcohol becomes acetic acid, and the liquid is then called *vinegar*, from two Latin words meaning *sour wine*. A great deal of vinegar is made from the juice of grapes and apples.

Beer. — Alcoholic drinks are also made by boiling sweet substances in water, and fermenting the liquid. These drinks are called *beer*. Root beer and birch beer are often made at home, but both of these drinks contain alcohol, and their use is harmful.



Malt.

The beer which is sold in barrooms is made from grain, principally barley. The grain is first made wet, and is then spread on a floor until it sprouts. The

growing stems change some of the starch of the grain to sugar. The grain and its sprouts are then called *malt*.

Beer is made by boiling malt with hops, and fermenting the liquid. It contains about 5 per cent of alcohol. Some kinds of beer also contain a small amount of food substances which were dissolved from the malt. But the malt which is not dissolved by the boiling contains most of the food substances of the grain. It is usually dried and sold as food for cattle. When grain is made into beer, men get the part which is harmful, and cattle get the part which is a valuable food.

The people of the United States use a greater quantity of beer than of any other kind of strong drink. Over a billion gallons are manufactured each year. This is equal to a large glassful for each inhabitant each day of the year. Sixty millions of bushels of grain are used in making the beer. This is enough grain to feed all the inhabitants of the country for nearly a month.

Distilled Drinks. — Alcohol boils at a cooler temperature than water. When a mixture of alcohol and water is heated, the alcohol will rise as a vapor before the water is hot enough to form much steam. If the vapor is collected and cooled, it will become a liquid again. The first liquid which is collected from the heated mixture will be mostly alcohol. In this way alcohol may be separated from water. Separating alcohol from other substances by boiling the mixture and cooling the vapor is an example of *distillation*.

If any liquid containing sugar is fermented and distilled, the liquor which is obtained will be rich in alcohol. Brandy is an alcoholic drink which is made

by distilling wine. Whisky is made by distilling the fermented liquid from boiled grain. Rum is made by distilling fermented molasses. Each of these drinks is about half alcohol.

A great deal of what is called brandy and whisky is made by boiling fruit skins, spoiled fruit, potato peelings, and other waste substances containing sugar or starch, and then fermenting and distilling the liquid. This makes a cheap kind of strong drink. This drink may be made to taste and look like the more costly kinds, but it is more poisonous than the drinks which are made from good fruit and grain.

Uses of Alcohol. — Pure alcohol is a liquid which looks like water. It will dissolve many substances which water will not dissolve, and for this reason it is largely used in manufacturing. Meat placed in it will not decay, and so it is used in schools and colleges for preserving specimens. It will burn with a hot flame without smoke, and so it is often used for heating and cooking. Its mixture with air will explode, and so it is sometimes used in engines in the place of gasoline.

There are two kinds of alcohol in common use. One kind is made from wood, and is used in manufacturing, but it is too poisonous to be used as a drink. The other kind in common use is that made from grain.

Grain alcohol is taxed by the government. It is sometimes mixed with wood alcohol and other substances which give it a bad taste and make it unfit for drinking. It is then called *denatured* alcohol. This

kind is not taxed, and is much cheaper than pure grain alcohol. For this reason it is the kind which is used for most purposes except drinking.

Regulation of the Sale of Alcoholic Drinks. — The use of strong drink is dangerous, and most states have laws which forbid any one to sell it without a permit or license from the government. The government charges a large sum of money for a license, but the money which is received does not pay for more than a small part of the harm which comes from the sale of the drink. Some towns and states have laws forbidding the sale of any kind of alcoholic liquor for drinking purposes. These laws are called *prohibition* laws. The reason for making them is that many persons get such strong appetites for strong drink that they cannot help taking it, even when they know that they are doing great harm to themselves, and to their families and neighbors.

Drunkenness. — Strong drink produces two kinds of harmful effects on those who take it. One kind of harm is that which comes on within a few moments after the drink is taken. This effect is called *drunkenness*, or *intoxication*. Drunkenness is a severe sickness of both the body and the mind. It harms a person like any other form of sickness.

A person who is drunk is not in his right mind. He is often quarrelsome and cruel. He cannot attend to his business, and often allows his family to suffer. He will often steal, and lie, and cheat, and will commit

crimes which he would not commit if he were in his right mind. About half of the prisoners in the jails of the United States are there as a result of strong drink. Drunkenness is a crime, and in many towns and cities those who are seen drunk on the streets are arrested and punished.

The other kind of harmful effect which is produced by alcoholic drinks is a slow poisoning of the whole body and mind. This effect may come from taking small quantities of drink often, even though the person does not get drunk.

The effects of alcohol on each part of the body will be described as each of the organs is studied.

Alcohol a Stimulant. — Alcohol acts like a whip to the mind and the body. The old Romans called a whip a *stimulus*, and for this reason alcohol is called a *stimulant*. A whip does not make a person or an animal strong. There are far better ways of getting a man to work than by driving him with a whip, or with a stimulant.

Alcohol rouses a person up, and he may then think that his strength is increased because he feels like doing something. But the drink really disturbs him in his work, just as whipping a boy in school every few minutes would disturb him in getting his lessons. A difference between a whipping in school and a stimulation with alcohol is that the whipping causes pain at once; but alcohol dulls the mind, and prevents the harm from being felt until afterward. This is the

great danger from taking alcohol, for it deceives the drinker, and makes him think that he is being helped, when he is really being harmed.

Alcohol a Narcotic. — The mind of a man who is stimulated with alcohol is benumbed and cannot act right, even though it tries to do so. For this reason alcohol is called a *narcotic*, from a Greek word meaning to make numb.

Why Men Drink. — Men give many reasons for drinking. Some say that they drink to keep warm, and others to keep cool. Some drink to make themselves think, and others to keep themselves from thinking. Some drink in order to go to sleep, and others to keep awake. These are only excuses for drinking. Men drink because they are mistaken with their appetites, and suppose that their feelings always show what their bodies need.

Most drinkers suppose that they can take a little alcohol without harm, and that they can stop drinking before they begin to be harmed. This is not so. The alcohol benumbs their thoughts and feelings. They cannot judge of the harm which they are doing to themselves, but they often keep on drinking and injure themselves for life. It is not safe to begin to take any kind of strong drink at all.

Another reason why men drink is because they meet their friends in saloons and barrooms. There they find warmth, easy chairs, and games which they may use free of charge if they buy strong drink. A great

many men go to saloons and barrooms because of these pleasures, and in this way they finally learn to take strong drink when they did not care at all for it at first.

One method of keeping men away from saloons and barrooms is to provide them with meeting places where they can be as comfortable as in the drinking places. Some churches and temperance societies are trying to do this kind of work.

The Custom of Treating. — The custom of inviting friends to drink is one of the principal causes which lead men to take strong drink. Those who drink usually treat their friends, and drink when they are invited by others, and in this way they drink when they do not wish to. The custom of treating also leads men to take far more liquor than they had expected to take. If each man should buy his drink in the same way that he buys his bread and shoes, there would not be nearly so much drinking as there is.

It is the custom for young persons to treat each other to ice cream, soda water, and candy, and thus they grow up expecting to carry out the custom of treating all through their lives. It is a fine thing to be generous, and to divide what we have with others, but it is wrong to divide simply for the sake of appearing generous. There is no more reason why boys and girls should treat each other to soda water than there is for them to treat each other to pencils and books. Temperance work would be greatly helped if the custom of treating were entirely abolished.

QUESTIONS

Of what use are the appetites?

Name some false appetites.

What is *intemperance*?

What is *yeast*?

What is *fermentation*?

What substances are produced by yeast in a fermenting liquid?

How is wine made?

Why is fermented wine harmful, while the fruit juice of which it is made is a good food?

What harmful substance does cider contain?

How is vinegar made?

What is *malt*?

How is beer made?

How much alcohol is in beer?

How is whisky made?

Name some uses of alcohol.

What is *wood alcohol*?

Why is it right to have laws regulating the sale of strong drink?

What are *prohibition laws*?

What is meant by *drunkenness*?

What is a *stimulant*?

What is a *narcotic*?

Explain in what respect alcohol is both a stimulant and a narcotic.

Name some ways in which the habit of drinking alcoholic liquors is formed.

What harm is done by the custom of treating?

CHAPTER VI

NARCOTICS

Tobacco. — Tobacco is a narcotic that was first used by the American Indians. The early settlers and ex-



Tobacco plants.

plorers sent ship loads of it home, and its use spread quickly over all the known world. Millions of pounds are now raised every year in the United States, and millions more are brought into the country. There are a greater number of stores and stands for the sale of tobacco than there are for the sale of any other article.

A tobacco plant grows about as tall as a man. It has a central stalk which bears large, broad leaves. The leaves are gathered and dried, and are manufactured into smoking tobacco, chewing tobacco, and snuff.

Nicotine. — Tobacco contains a substance called *nicotine*, which is a powerful poison. Two or three drops of pure nicotine would make a man dangerously sick. Men use tobacco for the sake of this poison. The quantity of tobacco which is usually taken at once contains enough nicotine to kill a man, if all of it should be swallowed at one time. The reason why those who use tobacco are not killed by it is that they do not swallow much of the nicotine.

Why Men use Tobacco. — Men use tobacco because of its narcotic effects. They say that it quiets them and makes them feel restful. If it were of use in this way, it would be used in medicine and would be given to women and children, for they need quieting medicines as much as men need them. But it is too poisonous to be used in medicine, and no one now uses it in this way.

The real reason why men use tobacco is because they form a habit of its use. They take it for pleasure only, and to satisfy a false appetite for it.

Effects of Tobacco. — Tobacco produces a quick form of poisoning, and a slow form. The quick form of poisoning is a feeling of stomach sickness, with paleness and weakness. Most persons are made sick when they first try to smoke or chew. The body may become somewhat used to the poisonous effects of tobacco, but even the greatest smokers and chewers become sick when they take a little more than usual at one time.

When tobacco is used day after day, it produces a

slow poisoning of the heart, lungs, muscles, eyes, and other parts of the body. These effects will be mentioned when the separate organs are studied.

Tobacco and Young Persons. — Tobacco has a far greater poisonous effect on young persons than on those who are grown. Many boys think that while they are smoking, they look like grown-up persons. Using it prevents them from growing up strong and healthy. After a person has got his growth, he can stand an amount of poisoning which would make a young person dangerously sick. Young persons do not have the power of overcoming the poisonous effects of tobacco, just as they do not have the power to do hard work with their muscles.

Cigarettes. — Many young persons suppose that cigarettes are only slightly poisonous. A cigarette is not so poisonous as a large cigar, or a pipe-full of tobacco, because it is smaller than they. But the small quantity of nicotine that is in a cigarette is more poisonous to a boy than the large amount of nicotine in a cigar or pipe is to a grown man. The use of cigarettes by boys is so dangerous that many states have laws forbidding their sale to those who are under eighteen years of age.

Opium. — The dried juice of poppy plants is a gummy substance called *opium*. It contains morphine and other substances which are poisons. Opium is a valuable drug which is used in medicine to ease pain and to produce sleep. It is a strong narcotic poison, and

its use is so dangerous that only skilled physicians know how to give it safely. Yet many persons who begin to take it for pain form a habit of its use, just as men form a habit of using alcohol or tobacco. The opium habit is extremely dangerous, and those who form it seldom live more than a few months or years.

Opium in Medicines. — Medicines are often advertised in newspapers and almanacs as soothing sirups, or as cough cures, or as pain killers. Many of these medicines contain opium, and it is the opium which produces their quieting effects. The medicines will not cure a sickness, but they will make it worse. What they really do is to dull the feeling of pain, and the person who takes them may then feel better for a time, but the sickness goes on just as if the medicines had not been taken.

Many lives are lost each year because the sick take opium or morphine, and then suppose that they are out of danger because they feel no pain. A pain is only a sign of sickness. If you have a bad pain and it is taken away by the use of opium or morphine, you need a good nurse or doctor to look after you, for the narcotic dulls your mind and feelings, and you cannot judge for yourself how ill you are.

Headache Cures. — Many medicines which are sold for the cure of headache contain drugs which make the heart extremely weak. These drugs do not cure the headache, and their use is dangerous.

Alcohol in Medicines. — A great many of the bitters and medicines which are advertised in newspapers and almanacs contain as much alcohol as strong wine. The alcohol is put into the medicines to keep them from spoiling. When a person takes a drink of one of these medicines, he takes as much alcohol as he would take if he should buy a drink of liquor at a saloon. Many persons keep Jamaica Ginger in the house for use in stomach troubles ; but it is only alcohol flavored with ginger. The laws of many states now require that the label on each bottle of advertised medicines shall tell what substances are in the bottle.

Drugs and Health. — Many persons suppose that some drugs will make them strong, that some will drive away diseases, and that others will make their complexions fair. This is not so. Nearly all drugs are poisons, and only trained doctors know how to use them. But giving drugs is only a small part of what a doctor does to cure a sick person. He tries to remove the cause of the sickness. For example, if a person is sick because he is tired from overwork, the doctor does not give him drugs, but tells him how to work and rest. The things which cure diseases as well as prevent them are not drugs, but they are such things as right eating and drinking, proper breathing, cleanliness, exercise, rest, and sleep. In the prevention and cure of sickness a knowledge of the use of drugs is of far less value than a knowledge of hygiene and of right living.

QUESTIONS

Who were the first users of tobacco?

What is *nicotine*?

What are the effects of nicotine on the body?

What effect does tobacco have on a person who takes more than he usually takes?

What effect does tobacco have on young persons?

Why are cigarettes often more harmful than large cigars?

What is *opium*?

What is *morphine*?

What substance do soothing sirups usually contain?

What is the danger from the use of opium in treating a pain?

What harmful effects do headache cures often have?

What harmful substance does Jamaica Ginger contain?

Of what value are drugs in making a person strong?

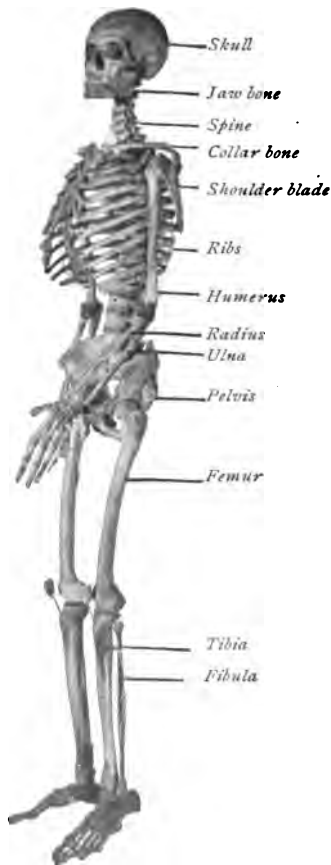
CHAPTER VII

BONES AND JOINTS

The Skeleton. — The flesh is supported by a bony framework called the *skeleton*. The bones weigh about one seventh as much as the whole body. They give firmness, stiffness, and shape to the body.

The size of the skeleton fixes the size of the body. If the bones are long and large, the body will be tall and large, but if they are small and short, the body will be small in size.

A bone is shaped somewhat like the part of the body in which it lies. The most of the bones of the arms, legs, hands, and feet are long and straight, like rods, and the most of the bones of the head are flat and thin, like sheets of card-



The skeleton.

board. The picture of a skeleton looks something like the picture of a very thin man, for the shape of every part of the body is outlined in bone.

Names of Bones. — There are about two hundred separate bones in the body, and each one has a name.

The long bone which reaches from the shoulder to the elbow is called the *humerus*. Two long bones extend from the elbow to the wrist. The one on the thumb side of the arm is called the *radius*, and the one on the little finger side is called the *ulna*.



X-ray photograph of the bones of the face.

Joints. — Bones are joined together in such a way that most of them may turn at the joints. The elbow joint is formed by the rounded end of the humerus fitting into a rounded notch in the ulna. The arm can bend at the elbow back and forth in only one direction, for the socket of the bones is long, and is rounded in only one direction, like a door hinge. The joint at the shoulder is shaped like half a ball, and allows the arm to turn in every direction.



X-ray photograph of the elbow of a grown man.

The backbone is made up of twenty-six bones which are piled one upon another like a long string of spoons.



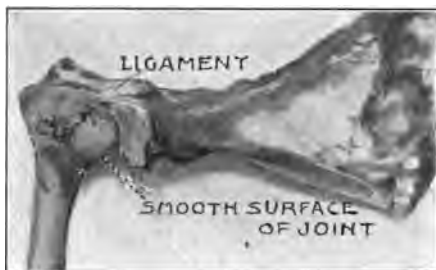
X-ray photograph of the elbow of a three-year-old child.

They are joined together by tough pads of flesh in such a way that the whole string of bones may bend somewhat, although the motion is slight between any two bones.

The edges of the bones of the skull are very irregular, and are fitted to-

gether like a dove-tailed joint in a box. These bones have only a very slight motion at their joints. The only bone of the head which can move freely is the lower jaw.

Ligaments. — Bones are joined together at the joints by strong connective tissue bands called *ligaments*. What we call *gristle* on a



Ligaments of the shoulder joint of a sheep.

soup bone is composed mostly of ligaments. Many of the tendons of muscles are also fastened to the bones at the joints, and act as ligaments to hold the bones in place.



Tendons fastened to the ligaments of the shoulder joint of a sheep.

The ligaments of a shoulder, or elbow, or other joint which may be freely moved, surround the bones like a collar, thus forming a pocket within which the ends of the bones turn. Each pocket

contains a liquid, called the *synovial fluid*, whose use is to make the ends of the bones smooth and slippery, like an oiled hinge.

The bones of the wrist are small and rounded, like pebble stones. Ligaments of connective tissue bind them together so firmly that they seem like a single bone. Yet the ligaments will stretch slightly when the wrist is struck or strained, and the wrist will not be broken so easily as it would if composed of a single bone.

Sprained Joints. — When a joint is turned too far, or in the wrong direction, the ligaments are stretched and torn. The joint then becomes sore and swollen, and the skin around it may become blue from the bleeding of the torn ligaments.

We may help a person who has a sprained joint by soaking the joint in hot water for an hour or two. Then a bandage wound snugly around the joint will help to prevent the pain and swelling from returning. After a rest of two or three days a sprained joint will be helped by moving it, even if the motion causes some pain. If the joint is not moved early, the torn ligaments may grow together too short, or may grow fast to the bone, and the joint will then be stiff and painful for a long time.

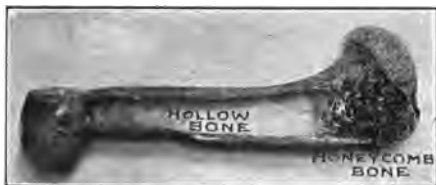
Dislocated Bones. — When the ends of the bones in a joint slip past each other, we say that the bones are out of joint, or *dislocated*. Putting a bone out of joint tears some of the ligaments of the joint.

Boys sometimes put their fingers out of joint in playing baseball. If a finger is out of joint, you can put it back in place by pulling upon it.

If a large joint, such as an elbow, is dislocated, bind the limb to the body, or to a narrow board, so as to keep the injured parts at rest. You can then move the person home without danger.

Structure of Bones. — The shafts of long bones, such as those in the arms and legs, are hollow, like the frame of a bicycle.

Their ends are like a fine honeycomb, or sponge, covered with a shell of hard bone. This arrangement makes



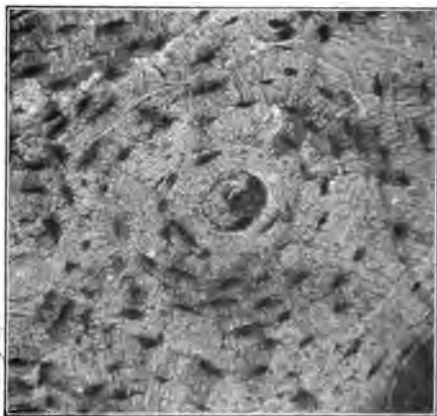
A long bone sawed in two.

them light and yet strong. A long bone is about twice as strong as an oak stick of the same size.

A flat bone, like one from the head, is composed of two sheets of hard bone, separated by a network of spongy bone. By this means the parts inside of the head are protected in a much better manner than if the bone were a single sheet.

A dried bone is two thirds lime. Soaking a bone in a mixture of one part of hydrochloric acid in ten parts of water will remove the lime, leaving the bone so soft that it may be tied in a knot. Burning a bone will remove the connective tissue, and leave the lime in the exact shape of the bone.

Bone Cells. — Bone is composed of cells of connective tissue, arranged in circles around the blood tubes. The cells have small bodies, and a great number of fine



Bone cells.

branches. They are the living parts of bones. Their special work is to take lime from the blood, and to fix it among their branches in order to make the bone hard and stiff. Every cell of the body takes a small

quantity of lime from the blood for its own use, but bone cells take a great deal of lime, and use it for the benefit of the whole body.

Cartilage. — A thin, tough pad of gristle, called *cartilage*, covers the end of each bone in a movable joint. A layer of cartilage also joins the bones



X-ray photograph of the hand of a thirteen-year-old child.

together in immovable joints. Cartilage is like bone which contains only a little lime. Each bone of a very young child consists largely of cartilage which takes up lime and becomes true bone as the child grows.

Bone Deformities. — While the bones are young and soft, they may bend slightly if pressure is put upon them. If the pressure is kept up day after day, the bones may grow crooked and deformed. The weight of the body may bend the bones of a poorly nourished baby, thus producing bow legs. The



X-ray photograph of the hand of an eight-year-old child.

backbone may grow crooked from sitting at a desk which does not fit the back. If a child has its nose so stopped up that it has to breathe through its mouth, the bones of the upper jaw may be compressed sidewise so much that the upper teeth pro-

ject beyond the lips. Most deformities of the body may be prevented by attention to the bones while the child is growing.

Small children who are fed with only bread and coffee, or with other improper food, may not take enough lime into their bodies to make their bones hard. These children often grow up with small and deformed bones. The deformities may be prevented by giving the children a variety of nourishing food, such as fresh vegetables and meat.

Bone Diseases. — The solid part of a bone contains blood tubes, and grows in the same way that flesh grows. Disease germs may enter a bone, and cause it to become swollen and softened. Hip joint disease is a form of lameness caused by the germs of tuberculosis growing in and around the hip joint. Hunchback is caused by tuberculosis germs growing in some of the bones of the upper part of the backbone, and causing them to become so soft that the weight of the body flattens them.

Repair of Injured Bones. — A bone is covered with a tough skin, called *periosteum*, which helps to form new bone when the old bone is injured or diseased. When a bone is broken, the connective tissue cells form new cells, and fill the space between the two ends with soft flesh. The new flesh then takes up lime, and in a month or two it becomes stiff bone.

How Bones become Broken. — The usual way in which a person breaks a bone is by falling upon it in

such a way that his weight comes upon it like a sudden blow. A child's body does not fall with so much force as the body of a heavy man, and so a child may not be harmed by a fall which would break the bones of a man.

The bones of a child do not contain so much lime as the bones of a grown person, and they may safely bend more than the bones of a man.



Too much lime in a bone makes it

Wrist of a grown man, showing bone broken by cranking an automobile.

weak and brittle, like the stem of a clay pipe. Bones take up more and more lime as a person grows older, and old persons often get broken bones from falls which are too slight to harm a young man.

What to do for a Broken Bone. — A broken bone is painful, and the flesh near the break is usually bluish because of the bleeding of the bone. A break may be only a crack in a bone, and may appear like a bad sprain. It is often impossible to tell a break from a sprain unless an X-ray photograph of the bone

is taken. It is important to know whether or not a bone is broken, for rubbing and moving the injured part will harm a broken bone, but will help a sprain.



A broken arm bandaged.

If a bone is broken in two, it may be bent at the broken spot. A slight motion will cause great pain by rubbing the broken ends together.

You can help a person who has a broken bone by binding a stick or a thin board along the whole length of the limb, using handkerchiefs for bandages. After you have done this, the bones cannot move, and you can carry the injured person home without danger to the broken part.

QUESTIONS

What is the *skeleton*?

Name the principal bones of the arm.

What is a *joint*?

Describe a joint like that at the elbow.

Describe a joint like those between the bones of the backbone.

Describe a joint like those between the skull bones.

What is a *ligament*?

What happens to ligaments when a joint is sprained?

What should you do for a sprained joint?

What should you do for a bone that is out of joint?

How can you show that a bone is composed of both flesh and mineral matter?

What is *cartilage*?

What is a common cause of deformed bones?

What is a common cause of bone diseases?

How is a broken bone repaired?

Why do the bones of a child not become broken so easily as those of a grown man?

What should you do for a person who has a broken bone?

CHAPTER VIII

MUSCLES

Involuntary Muscles. — Nearly all movements in the body are produced by groups of cells called *muscles*. The movements are of two kinds. One kind is that which the mind cannot control, such as the flow of blood through the body, and the passage of food through the organs of digestion. The muscles which produce these movements are called *involuntary* muscles.

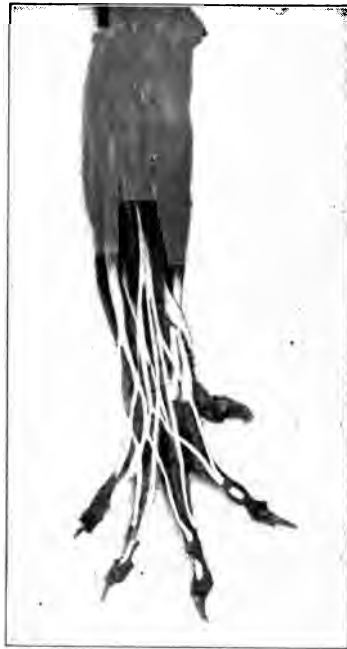
Involuntary muscles are almost white, or colorless. Most of them are in the form of thin sheets surrounding the blood tubes, and the tubes in which food is digested. They are composed of cells which are thick in the middle and taper toward their ends. When the cells act, they make themselves thicker and shorter. In this way they lessen the size of the tube which they surround, and produce motion in anything which the tube may contain.

Voluntary Muscles. — A second kind of motion in the body is that which is under the control of the mind, such as the movements of the arms, legs, and head. The cells which produce these movements are called *voluntary* muscles. By the word muscle we usually mean a voluntary muscle.

The muscles of the body of an animal are its lean meat. The muscles of a person are like the lean meat of a lower animal, and form about half of the weight of the body. The most of them surround the bones, and lie just beneath the skin.

There are about four hundred separate muscles in the body, each of which has a name. The muscle which lies on the front side of the arm above the elbow is called the *biceps* muscle. Its use is to bend the elbow. The muscle which lies on the back side of the upper arm straightens the elbow, and is called the *triceps* muscle.

Examination of a Muscle. — You can see what your own muscles are like by looking at the meat in a butcher's shop, for the muscles of the common lower animals are nearly the same in number and arrangement as the muscles of your own body. A leg of lamb consists of bundles of muscles surrounding the leg bones. Each muscle is large at its upper end, and tapers toward its



Muscles and tendons on the front of the foreleg of a cat.

lower end, where it ends in a strong white connective tissue cord called a *tendon*. The tendon is fastened to a bone in the lower part of the leg.

How a Muscle Acts. — When a muscle acts, it makes itself hard and firm, and becomes larger around and shorter than when it is at rest. In this way it draws its ends toward its middle part, and causes its tendon to pull upon whatever is fast to it. The shortening and hardening of a muscle is called its *contraction*.



Muscles and tendons on the back of the hind leg of a cat.

Nearly all the muscles of the arms and legs are arranged like the muscles in a leg of lamb. The upper end of each muscle is fastened to a bone, either in the trunk, or in the upper part of a limb.

The tendon at its lower end is fastened to another bone after crossing the joint. Each muscle usually connects two bones, and its action is to make the lower bone move at the joint like a door on its hinges. Nearly all voluntary motions of the body are the bending of joints.

You can see how a muscle acts by examining your own arm. Bend your elbow as far and as strongly as you can, and feel the biceps muscle swell in a hard bunch. Feel in the bent side of the elbow for the tendon as it pulls upon the forearm.

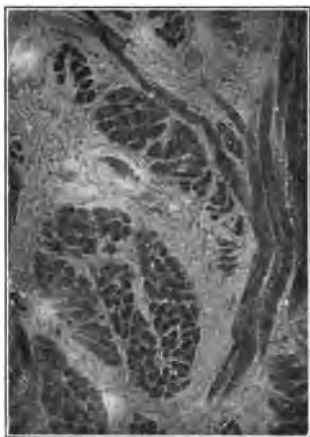
Face Muscles. — Many of the muscles of the face are fastened to the skin. When they contract, they move the lips and cheeks, wink the eyelids, and wrinkle the skin. The motions of the face often show how a person feels. If he is happy, his muscles will pull the corners of his mouth upward and backward in a smile. If he feels sad or is in pain, other muscles will pull the corners of his mouth downward, as in crying. If he is angry, the muscles will wrinkle his forehead in a scowl.

The face muscles which you often use will produce marks and wrinkles on the skin, and will show a great deal about your character and disposition. If you smile often, you will carry the marks of the smile through life. If you are often angry, you will carry a scowl upon your forehead. If you practice kindness and gentleness while you are young, you will carry their signs on your face all through life.

Structure of Muscle. — A voluntary muscle is composed of cells about the size and shape of short fibers of cotton. If you look at muscle cells under a microscope, you can see faint lines running across them. The cells lie side by side, and are held in their places by fine branches of connective tissue cells. Muscle cells are soft like jelly,



Muscle cells. *Magnified.*



Muscle cells cut across. *Magnified.*

but the connective tissue cells around them are almost as tough as fibers of cotton. The toughness of meat is due to the connective tissue in it.

The special work of muscle cells is to shorten themselves in order to produce motion in some other part of the body. There is a slight motion among the particles of every living cell, but a muscle cell can move so much that it produces motions in other parts of the body.

A tendon is composed of connective tissue fibers which are fastened to the connective tissue of the muscle.

Strength of Muscle. — A muscle one inch in diameter can lift about seventy-five pounds. Frogs and grasshoppers seem to be much stronger than a man of the same size would be, but this is only because their bodies are lighter. Their muscle is only half as strong as a bit



Connective tissue at the end of a tendon.

of man's muscle which is of the same size as theirs.

It would be a simple problem in arithmetic to reckon the strength of one of your muscles. Feel of your biceps muscle, measure its diameter, and find out how many bundles one inch in diameter would be needed to make a bundle as large around as your muscle. From this you can tell how many pounds your muscle can lift by a direct pull.

Source of Muscular Strength. — A fine network of blood tubes surrounds each muscle cell. The blood which flows through the tubes brings both food and oxygen to the cells. When a muscle contracts, it takes some of the oxygen and oxidizes either some of the food, or some of its own substance (p. 31). The oxidation supplies the power and strength which the muscle puts forth in its work.

The contraction of a muscle may take place in an instant, like the uncoiling of a spring suddenly released, or the muscle may contract slowly, like a spring pulling steadily. A contraction is started by an order which the brain sends to the muscles by means of a nerve.

Muscle Growth. — Using the muscles is called *exercise*. A muscle at rest takes very little food and oxygen from the blood. If muscles are not used, they soon become small and weak, but when they work, they use up a great deal of food and oxygen, and take in a large supply from the blood. Muscle cells are

living things, and when they are often called upon to do work, they prepare themselves for it by storing up a supply of food in their own substance. For this reason exercise makes the muscles grow large and strong.

Many young persons take exercise to make their bodies grow shapely and beautiful. They go to gymnasiums to have the size of the muscles measured, and their strength tested, and to have the instructors tell them what exercises will increase their size and strength. If their upper arms are small, they take exercises which require the arms to be moved at the elbow, and in this way they increase the size of their biceps and triceps muscles. A young person can develop any part of the body by exercising it.

Turning your ankles when you stand or walk is due to a weakness of the muscles of your legs. You can strengthen those muscles and make your ankles strong by practicing standing on tiptoe, or by taking walks uphill.

Round Shoulders. — The principal support of the arms and shoulders are the muscles on the back side of the neck and trunk. If the muscles are weak, the shoulders fall forward, producing round or stooped shoulders. The straight back and full chest of a soldier are due to training the muscles which hold the shoulders up. You can exercise the muscles of your back by always holding your shoulders up when you sit or stand. In a little while your muscles will grow

so strong that they will support your shoulders without your thinking about their action.

Exercise and Endurance. — Exercise trains the muscles to work for hours at a time, and to endure hard labor without tiring. Athletes and circus actors have to take exercise every day in order that their muscles may endure their work. If they should stop exercising for a few days, their muscles would become tired soon after they begin to do their acts.

Every person has to make some use of his muscles. Even writing at a desk requires muscular work to hold the body upright, and is extremely tiresome to those whose muscles are weak. Many scholars fail in their work because they do not cultivate enough muscular strength to enable them to sit at their desks all day. Riding in an automobile or in a railroad train requires an amount of muscular work which often tires a strong man. You cannot have strength and endurance to carry on your daily work unless you take exercise every day.

Exercise and Health. — One of the greatest of all reasons for taking exercise is to keep the whole body in good order. Muscles use up the greater part of the food and air which enter the body. If they are in good order, the digestive organs try to supply them with a large quantity of food, the lungs take in a large amount of air for their use, and the heart sends the blood flowing swiftly to carry them what they need. The whole body receives benefit from exercise of the muscles.

When you do not use your muscles, you have very little need of food. You do not have much appetite, and your stomach digests only a little food. You also have very little use for oxygen, and you breathe lightly. All the actions in your body are lessened, and you feel dull and weak all over. You must take exercise if you would keep your body well and strong.

Kind of Exercise. — While you sit at a desk all day, you use your muscles in a gentle way which finally tires them, but the work which they do does not require you to breathe deeply, or your heart to beat hard. The kind of exercise which helps you is that which makes you breathe deeply, sends the blood to your face, and warms your whole body. Every man, woman, and child needs at least an hour of this kind of exercise every day. Scholars at school cannot have clear minds unless they take at least this amount of exercise.

If you have to work with your hands, you will get exercise while you work. Farmers, carpenters, errand boys, and house maids, all get exercise while they do their work. But students and bookkeepers often have very little muscular work to do, and they may get exercise by walking, bicycling, rowing, fishing, playing outdoor games, and taking part in athletic sports.

One of the best ways of taking exercise is to become interested in some kind of active work or sport. Fads and sports, such as photography, gardening, and fishing, have often been the means of leading sickly persons to take needed exercise, and of restoring them to health.

Muscles need pure, fresh air as much as they need good food. The best exercise is that which is taken out of doors where the air is pure and free from dust.

Gymnasiums and Playgrounds. — Children in large cities often have no work to do, and no place to play. It is the duty of those who have them in charge to provide the means and the places for their exercise. It is a good investment for taxpayers to give their money for gymnasiums, playgrounds, and parks, where children can play and develop strong, healthy bodies.

Alcohol and Muscular Strength. — Many experiments have been made to find out whether or not the use of an alcoholic drink will increase a person's strength. These experiments have always proved that alcohol lessens the strength instead of increasing it. Athletes in training are not allowed to drink any form of alcoholic liquor at all.

Alcohol and Endurance. — Experiments have been made to find out whether or not alcohol will help a person to put his muscles to hard use for hours at a time. They prove that alcohol lessens the endurance. No civilized nation now supplies alcoholic drinks to its soldiers and sailors as was formerly done, for on long marches and in severe hardships those who drink are the first to fail in strength. No explorer in deserts and arctic lands will allow his men to use strong drink.

Alcohol and Accuracy of Motion. — Experiments have been made to find out whether or not alcoholic drinks will help a person to do quick and accurate

work with his muscles, such as setting type or shooting at a mark: It is proved that alcohol always lessens the speed and accuracy of the worker. But very often it deceives a person and makes him believe that he is doing his work more quickly and accurately.

Tobacco and Muscles. — The nicotine of tobacco is a poison to the muscles. Tobacco cannot increase the strength. Soldiers, sailors, and explorers sometimes say that tobacco helps them to do their work. They do not use tobacco to increase their strength, but to help themselves to be contented and to rest after doing hard work. If tobacco were of any value in helping tired persons to rest, it would be used in sickness. But those who smoke or chew do not care to do so when they are sick, for they then feel the poisonous effects of the nicotine just as if they had never used tobacco.

Tobacco is more poisonous to the muscles of a young man than to those of a grown person. A boy who smokes cigarettes cannot become a good athlete, nor endure hard work. The use of cigarettes will spoil a boy's reputation as a worker, and those who wish to employ bright, active boys will not take cigarette smokers if they can help it.

QUESTIONS

What is the difference between an involuntary muscle and a voluntary one?

Where may involuntary muscles be found?

How much of the body is composed of voluntary muscles?

How many muscles are in the body?

Where is the biceps muscle?

Where is the triceps muscle?

What is a tendon?

What change takes place in the shape of a muscle when it starts to act?

To what are the muscles of the arms and legs fastened?

When a muscle acts, what does it do to a bone or joint?

How do the muscles of the face produce a smile?

What is the shape of a muscle cell?

What is the use of connective tissue between the cells?

How many pounds can be lifted by a muscle one inch in diameter?

How could you reckon how much your biceps muscle can lift?

From what does a muscle get its power to act?

What makes you feel warm when you work hard with your muscles?

What causes muscles to act?

What is exercise?

What are some of the benefits which you may get from taking exercise?

If your arms are small, how may you increase their size?

If you become tired out after walking a few blocks, how can you increase the endurance of your muscles?

How does exercising your muscles help your lungs?

Name some good kinds of exercise.

Give a reason why the people of a city should vote money to pay for gymnasiums and playgrounds.

What effect does alcohol have upon muscular strength? upon endurance? upon accuracy of movements?

What effect does tobacco have upon the muscles?

CHAPTER IX

CIRCULATION OF BLOOD

Use of Blood. — The cells of the body eat, breathe, and grow, like separate microscopic animals outside of the body. They cannot go in search of food and oxygen, but everything which they need is brought to them by a red liquid that is always flowing through every part of the body. This liquid is the blood. The blood also takes away the waste matters which the cells give off, and it protects the cells from disease germs which may enter the flesh. The life of the body depends upon the blood.

Composition of Blood. — Blood consists of a clear, yellow liquid called *plasma*, or *serum*, which is full of cells called blood cells, or *corpuscles*. About one half of the blood is plasma, and the other half is blood cells which float in the plasma.

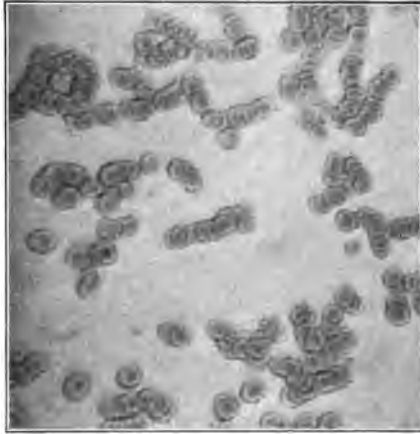
Plasma. — The plasma of the blood consists of water containing protein, fat, sugar, and minerals, all of which are to become food for the cells of the body. It also contains small quantities of waste matters which it has washed away from the cells.

Clot. — After blood flows from the body, it becomes solid, like jelly. Blood in a solid form is called a *clot*.

The effect of clotting is to form a solid mass which will stop the bleeding in a cut or wound.

Red Blood Cells.

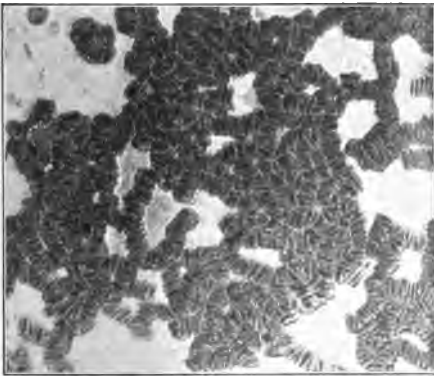
— Most of the cells which float in the blood are red, and give the red color to the blood. They may easily be seen by examining a thin



Red blood cells.

smear of blood with a microscope. A red blood cell is shaped like a thick round plate with a hollow on each side.

The use of the red blood cells is to carry oxygen from



Red blood cells in piles.

the lungs through the body. They do this by means of their red coloring matter, called *hemoglobin*, which contains iron. Every cell which touches the air on the outside of the body takes oxygen for its own use;

but red blood cells take far more oxygen than they themselves need, and they carry it to the cells which lie deep in the body and cannot get it for themselves.

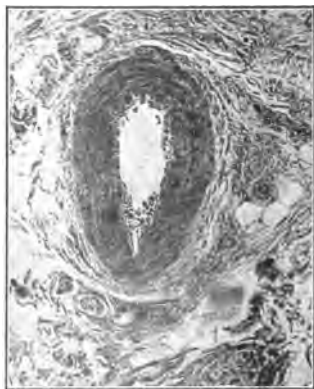


White blood cells.

White Blood Cells. — Some of the blood cells are round like balls, and are almost colorless, but when many of them are seen together they appear white. These are called *white*

blood cells, or *white corpuscles*. One of their uses is to destroy bacteria and other disease germs which may have entered the body. We can see white blood cells by looking at the white matter from a pimple with a microscope. This matter consists of white blood cells which bacteria in the pimple have destroyed.

Arteries. — The blood in the body is held in tubes, and is kept in motion by a pump called the *heart*. The heart sends blood to every part of the body by means of a set of tubes called *arteries*. All the arteries, except those in the lungs, are branches of a single artery which begins at the heart, and is called the *aorta*. The larger arteries



A small artery cut crosswise.
Magnified.

lie deep in the flesh where they cannot be easily harmed.

The larger arteries in the body have been given names. For example, the one on the thumb side of the wrist is called the *radial* artery.

Muscles of the Arteries. — The arteries are elastic, like rubber tubes. Their walls consist largely of involuntary muscle cells which may contract or relax, and make the tube small or large, according to the needs of the various parts of the body (p. 76). When any part, such as an arm, is put to hard use, its arteries become large in order to supply a large amount of blood to it. When a person is too warm from running, his face is red, because the arteries become large in order to allow a large amount of blood to flow near the air and become cooled.

The contraction of arteries may be seen in an earthworm. A large blood tube runs along its back and another along its under side. By watching a tube closely you can see it contract regularly about once every four seconds. The earthworm has no heart, but the regular contractions of the blood tubes keep the blood in motion.

Veins. — The blood is returned to the heart by means of a set of tubes called *veins*. The veins are like the arteries, except that in them the blood flows from the small branches into the large trunks. These large trunks open into the heart. We can see veins on the back of the hand by holding the hand down at arm's

length for a moment. The blood will fill the veins, and will make them look like bluish ridges on the skin.

The larger veins in the body have been given names. For example, the principal vein on the side of the neck is called the *jugular vein*.

Valves of the Veins. — Veins contain valves which open toward the heart. When a muscle contracts, it squeezes blood from its veins. The blood must flow onward, for the valves prevent it from flowing backward. Thus exercise helps the flow of blood through the body.

If a person is weak and sick, the heart may not be strong enough to force the blood rapidly through the veins of the arms and legs. Rubbing the limbs toward the body will help the flow of blood, and be refreshing to the sick person.



Veins on the hand, full.

Proof of the Flow of Blood.

— The movements of the blood were not known until an English physician, named William Harvey, discovered them about 1628. You can easily perform one of his experiments to prove how the blood flows.

Press a finger upon a vein on the back of the hand, and rub another finger from it toward the heart in order to empty the vein of blood. Lift the second

finger and blood will return and fill the upper part of the vein down to a set of valves, but the lower part of the vein will remain empty. Now lift the lower finger, and blood at once fills the whole vein. This experiment shows the direction of the flow of blood in the veins of the hand.

Capillaries. — Blood goes from the smallest branches of the arteries into the smallest branches of the veins by passing through a set of fine tubes called *capillaries*. The capillaries extend around and between the cells



Experiment to show the action of the valves in the veins.

of the body in a network so fine that every cell touches one or more of the tubes. Capillaries are so small that the separate ones cannot be seen without a microscope. They are so numerous and so close together that they make the skin look as if it were painted pink. Pressing a finger on the skin will force the blood from the capillaries, and when the finger is lifted, it will leave a white spot for a moment until the blood fills the capillaries again.



Capillaries around muscle cells.

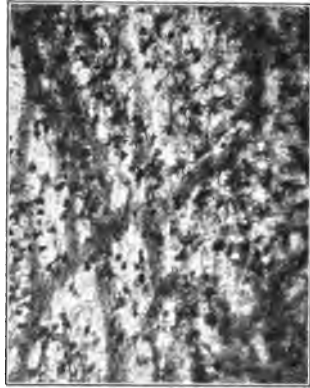


A fish arranged under a microscope to show the circulation of blood.

The walls of the capillaries are so thin that some of the plasma and oxygen from the blood easily soak through them and stay behind for the use of the cells, while the rest of the blood passes into the veins. At the same time, carbonic acid and other waste matters from the cells pass into the blood stream and flow away through the veins. Thus the capillaries distribute food

and oxygen to the cells and take away their waste matters.

Seeing Capillaries. — You may see the flow of blood through the capillaries by using a microscope and examining the tail of a very small fish, or the web of a frog's foot, or the thin sheet of tissue, called the mesentery, which holds the frog's intestine in place. The blood cells in a capillary appear like orange-colored balls tumbling over and over



Capillaries in a frog's foot.



Heart of a lamb.

as the blood carries them along. A capillary is usually of such size that it allows from two to four red blood cells to pass through side by side.

The Heart. — The heart is made of firm muscle, and is about the size and shape of a person's fist. Its smaller end may be felt throbbing under

the skin a little to the left of the lower end of the breastbone. It is hollow, and is divided into four compartments, two of which are called *auricles*, and two are called *ventricles*. Each auricle receives blood



The valves between an auricle and a ventricle.

from the veins, and each ventricle sends blood into an artery.

How the Heart Pumps Blood. —

The ventricles have thick walls of muscle which form the greater part of the heart. Each ventricle has a door, or *valve*, opening inward from the auricle, and another valve opening outward at the beginning

of the artery. A ventricle receives blood from its auricle, and when it is full, it suddenly contracts and becomes smaller, thus forcing the blood out. The valve at the auricle does not allow the blood to flow backward into the auricle, but the valve which opens outward allows it to flow into the artery.

After the ventricle has emptied itself, its muscles

relax and allow more blood to enter from the auricle, but the valve at the artery closes and does not allow the blood to flow backward from the artery. In this manner the ventricles keep the blood flowing through the arteries away from the heart.

Pulse. — The heart of a grown person contracts or beats about seventy times each minute, and each beat sends about four tablespoonfuls of blood into the arteries. The blood flows through



The valve which prevents blood from flowing from the main artery back into the heart.

the arteries in spurts or waves called the *pulse beats*. You can feel the pulse when you press lightly upon the flesh over a large artery. By feeling the pulse you can tell how fast and how strongly the heart is beating. One of the best places to feel the pulse is in the radial artery on the front of the wrist (p. 91).

Venous and Arterial Blood. — Blood which is full of oxygen is bright red in color, but it becomes dark red or purple when it loses the oxygen. Blood in the arteries is bright red, for it is then carrying a large quantity of oxygen to the cells of the body. It loses its oxygen in passing through the capillaries, and so its color is purple in the veins. You can see the difference in

color between arterial and venous blood by looking at the veins in the back of a person's hand. The skin is colored pink by the arterial blood in the capillaries,

but the blood in the veins is bluish, for it contains but little oxygen.

Circulation of Blood. — The flow of blood through the body is called the *circulation*. The venous blood which comes back to the heart contains but little oxygen, and is full of carbon dioxide which it has taken from the cells. Before it is sent through the body again, it is sent to the lungs to get rid

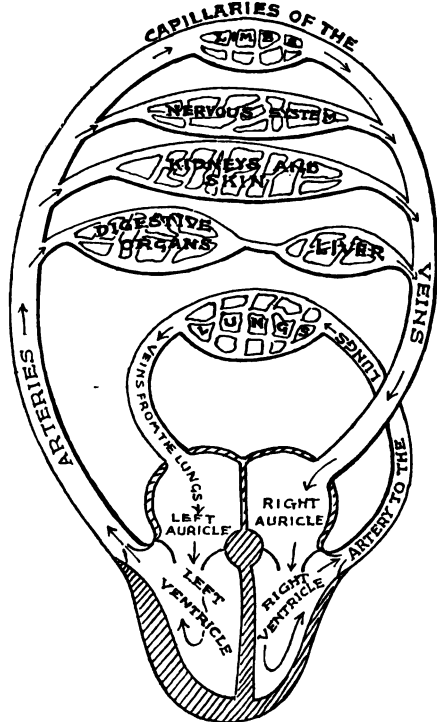


Diagram of the circulation of blood.

of the carbon dioxide and to get a load of oxygen.

The heart is a double pump. Its right ventricle pumps blood to the lungs, and its left ventricle pumps it to all the body. Even the tissues of the lungs receive blood from the left ventricle.

A drop of blood will go the full rounds of the circulation in about two minutes. In doing so it will pass through the following structures: —

- | | |
|--------------------------------------|-----------------------------|
| 1. Left ventricle | 6. Right ventricle |
| 2. Arteries of all parts of the body | 7. Artery to the lungs |
| 3. Capillaries | 8. Capillaries of the lungs |
| 4. Veins | 9. Veins to the heart |
| 5. Right auricle | 10. Left auricle |
| | 11. Left ventricle again |

Lymph. — The plasma which passes through the sides of the capillaries and goes to the cells is called *lymph*. It surrounds the cells of the body and fills all spaces among the tissues, like water in a sponge. The cells of the flesh lie in the lymph like fishes in water. They take their food and oxygen from the lymph and give off their waste matters to it. The liquid which stands on the raw flesh after a bit of skin has been knocked from the knuckles is lymph.

The Flow of Lymph. — The lymph in the flesh is slowly returned to the blood in the veins near the heart by a set of tubes called *lymphatics*. These tubes are so small and thin that they can scarcely be seen. They are arranged like the veins, and contain valves which allow the lymph to flow only toward the veins. When the muscles contract, they press upon the lymphatics and force the lymph out of the flesh, and into the veins. Thus muscular exercise helps the flow of the liquid which nourishes and cleanses the cells.

Rubbing the limbs toward the body is refreshing to

a sick person, for it makes the lymph flow back to the veins, and thus removes the waste matters from the tissues. The rubbing also helps the flow of blood through the veins (p. 92).

Circulation and Water Supply Compared. — The circulation of blood in the body is like the water supply of a city. The heart is like the pumping station.

The arteries are like the pipes which lead from the pumping station, and send branches to the faucets in the houses.

The flow of blood in the capillaries is like the flow of water from the faucets. The use of the arteries is to carry blood to the capillaries, just as the use of the water pipes is to carry water to the faucets.

The veins are like the waste pipes and sewers which carry the waste water from the houses. A difference between them is that the veins return the blood to the heart to be pumped over again, while the sewers empty the waste water at a distance from the pumping station.

Lymph is like water which has been drawn from a faucet, and is taken away to be used in cooking or washing. After lymph has been used, it is returned to the veins, just as the water which has been taken away from the faucets is finally poured into the sewers.

Heart and Exercise. — Cells have use for much more blood while they are at work than while they are at rest. The heart is like a water pump that regulates itself. When a person takes exercise, his heart beats strongly and rapidly in order to send a large amount of blood

to the muscles. Count your pulse while you are sitting quietly in your seat, and you will find it beating about seventy or eighty times a minute. Then run up and down stairs or around the schoolhouse, and count your pulse again. It will now beat over a hundred times a minute, and may be felt much more readily than while you were sitting still.

Exercise will strengthen the heart, as it will any other muscle in your body. But there is danger in taking too much exercise, for it may cause your heart to become too large for the needs of your body. The heart may then wear itself out by useless work, and may finally become weaker than if you had not taken exercise. Running long races until you can scarcely stand is an example of the kind of exercise which is harmful.

Many famous athletes of schools and colleges have injured their hearts by training too hard. It is a fine thing to cheer the contestants in a sport or game, but remember that your cheering may lead the athletes to overwork themselves and to injure themselves for life.

The Heart and Sickness. — When a person is sick, the poisons of the disease make his heart weak. The heart then beats fast in trying to supply the cells with all the blood that they need. One of the greatest dangers in a sickness is that the heart may tire itself out. The pulse is one of the best signs of the severity of a disease. It is a sign of dangerous sickness when the heart beats hour after hour twice as fast as during health.

A person may think that he has heart disease when he feels his heart beating hard, or his pulse throbbing in his head. These feelings are not always signs of heart trouble. They are usually due to overeating, or to gas in the stomach pressing against the heart, and they pass away when the stomach does its work properly. The principal sign of real heart disease is shortness of breath caused by failure of the blood to carry oxygen to the cells.

Blood Pressure. — The heart forces blood through the arteries with enough pressure to cause a stream to spurt up three or four feet when a large artery is cut. If the blood pressure is increased, the heart must beat hard in order to force blood into the tubes. An increased pressure of the blood also causes the blood to flow too fast for the proper changes to take place in the capillaries. Physicians often test the blood pressure when they examine a person. An increased pressure is usually a sign of sickness and danger.

Hardened Arteries. — A healthy artery is soft and elastic, like a piece of new rubber. The walls of the arteries of very old persons usually become hardened with lime. The arteries are then like a piece of old rubber, and are in danger of bursting, for they cannot stretch when the heart beats hard. An old person is likely to die of apoplexy, caused by the bursting of a hardened artery in the brain.

Many persons in middle life suffer with hardened arteries and increased blood pressure. One of the

principal causes of hardened arteries and increased blood pressure is continuous hard work and worry. Proper rest and play are as necessary for a busy grown person as for a schoolboy.

Alcohol and the Heart. — An alcoholic drink seems to increase the force of the heart beats. Doctors formerly gave a great deal of alcohol to the sick. We now know that alcohol seldom makes the heart stronger. It seems to do so because it makes the arteries large, and allows blood to flow through them easily. The heart then seems to have a great deal of power, like an automobile engine which is running while the car stands still. But when a strain is put upon the heart, as in climbing stairs, the heart shows less power than when alcohol is not used. Doctors now give very little alcohol to the sick.

Alcohol and Arteries. — Alcohol is a poison to the muscles of the arteries, and prevents them from contracting when they should. The pressure of the blood then stretches the arteries and makes them large. Alcohol makes a drinker's face red because it increases the size of the arteries of the skin.

When the muscles of the arteries do not act, the flow of blood to the various organs cannot be regulated, but some organs will get more blood, and others will get less, than they need. This disturbance of the circulation is often the cause of diseases of the brain, kidneys, and other organs.

Tobacco and the Heart. — The nicotine of tobacco

is a poison to the muscles of the heart, just as it is to the muscles of the arms and the legs. If a great deal of tobacco is used, the heart often beats in an irregular way, or skips a beat now and then. Those persons whose hearts act in this way have great difficulty in getting their lives insured, for they are much more likely to become sick and to die than those whose hearts beat naturally.

QUESTIONS

- What is the circulation?
- Of what is blood composed?
- What are red blood cells? What is their use?
- What are white blood cells? What is their use?
- What is plasma? What is its use?
- What effect does clotting have on bleeding?
- What are arteries?
- Of what use are the muscles in the walls of arteries?
- What are veins?
- Of what use are the valves in veins?
- How does exercise help the flow of blood through the veins?
- What are capillaries?
- What changes occur in the blood while it is passing through the capillaries?
- Describe the heart.
- What is a ventricle?
- What is an auricle?
- Describe a heart beat.
- What is the pulse?
- Where may the pulse be felt?
- What is the difference between arterial and venous blood?

Through what structures does a drop of blood pass in making a complete round of the circulation ?

What is lymph ?

What causes the lymph to flow in the flesh ?

Compare the circulation of blood in the body with the water supply of a city.

What effect does exercise have on the heart ?

What effect does sickness have on the heart ?

What is the cause of a hardening of the arteries ?

What effect does alcohol have on the heart ? on the arteries ?

What effect does tobacco have on the heart ?

CHAPTER X

EMERGENCIES

Panic. — Accidents nearly always happen suddenly, and the danger is usually over in a very short time. If an accident happens in a crowd, one of the greatest of the dangers is that people will hurt one another in trying to get away from the place. Often those who are in an accident do not take time to think, but they push and throw each other down, and in that way they often do more harm than the accident itself. When the persons in a crowd become filled with fear and act without thinking, like a flock of frightened sheep, we say that they are in a *panic*. A sudden danger which requires quick action is called an *emergency*.

Fire Drill at School. — A cry of " Fire " in a crowded meeting place will often cause a panic. Lives have sometimes been lost in panics when a large number of people in a crowded hall have tried to escape at once from a harmless fire. Most panics are caused by too great a hurry to escape from a supposed danger. About two persons are all that can go through a doorway at once. If half a dozen try to crowd through at one time, some one is likely to be hurt.

Fire drills at school teach boys and girls how to go

out of a building quickly and safely. When an alarm bell is rung, the scholars drop their books and march out of the building in good order. In this way a large schoolhouse may be emptied in less than two minutes. This is far less time than it would take a fire to spread in a dangerous way.

The alarm bell for a fire drill is rung at an unexpected time, and the scholars do not know whether there is a real fire or not. When fires have occurred in schoolhouses in which the drills have been held regularly, the scholars have always escaped in safety, because they have been trained to think about what they are to do. The pupils have not crowded one another, but each has helped the rest to act in an orderly way. Scholars who have been trained in this way are likely to be cool and thoughtful when an accident happens or danger arises in any place.

Learning to Swim. — A great many persons lose their lives because they do not know how to float in the water. Many persons who can swim lose their lives in trying to save those who cannot swim, but who become frightened and pull their rescuers down with them. Over thirty persons were drowned in the New England States on a single day of August, 1910. Most of them would have been saved if they had learned to be cool when in danger, and had helped those who tried to save them. All of them would have been saved if they had taken the trouble to learn to swim while they were young.

You can easily learn to float or swim if you do not become frightened by a little water in your nose and face. You cannot sink if you do not breathe water into your body in the place of air. The reason why learning to swim is hard is because your head is heavy and presses your body deep into the water. If you had a long nose, like a dog's, and could hold it straight up, you would learn to swim as naturally as a dog does. Your body sinks so low that the water comes nearly up to your nose and frightens you; but you are in no danger so long as your nose is above the water.

It is your duty to learn to swim. Go to the water with a friend who knows how to swim, and make up your mind that you will not be frightened. Do as he tells you, and you will quickly learn to swim.

If a person is nearly drowned, you may be able to save his life by doing artificial respiration. The way to do this is described on page 130.

Curiosity of a Crowd. — When a person is hurt, those who are near by often crowd around him out of curiosity to see what is going on. This is the wrong thing to do, because it shuts off the fresh air from the injured person, and interferes with those who try to help him. When a person is hurt, do not rush to look at him, but keep away unless you are able to help. If a doctor or nurse is working over the injured person, you can do no good by looking on, but you are likely to do great harm.

How to Help an Injured Person. — If you are the only person near to some one who is injured, you may be of great help to him. There are always three things to think about in an accident: first, what is called the *shock* of the accident; second, bleeding; and third, broken bones.

Shock. — A person who falls, or is struck a hard blow, or is suddenly hurt in any way, usually feels dizzy, short of breath, and sick, and often does not know anything at all for a moment. This sickness is called *shock*. If a person is suffering from the shock of an accident, lay him down on his back, so that his heart and breathing may go on as undisturbed as possible. Do not rub him or shake him, for that might make the shock worse. Do not force him to swallow whisky or other strong drink. Alcohol in an accident seldom does good, but it often does great harm.

Bleeding. — A great danger in an accident is the bleeding from a cut or wound. A person may lose a cupful of blood without danger, but if he loses a pint, he will be weak and faint. Bleeding from a wound usually stops within five minutes, for the blood clots, and closes the open tubes (p. 89). If a large blood tube is cut, the blood may flow so swiftly that the stream washes away the clot as fast as it is formed. Bleeding from a cut artery is dangerous, for the blood spurts out as if it were forced from a syringe. Blood from a vein does not spurt out, but flows so slowly that it may easily be stopped.

How to Stop a Bleeding Wound. — Bleeding comes from an open tube, and you can always stop it by pressing or pinching the flesh



Stopping a bleeding by grasping the sides of the cut.

around the wound so as to close the blood tube. Press a clean handkerchief against the wound, if you can get one. If not, use your bare hand or finger. Many lives have been lost because no one has thought to do this simple thing.

Almost the only danger that is likely to come from pressing upon a wound is that dirt from your hands might get into the wound.

But you do not need to put your fingers or hand into a wound. You can stop the bleeding by pressing the flesh on both sides of the wound. Hold the wound closed until you can prepare a bandage, or until help comes. In this way you can stop the bleeding from the largest arteries.



Stopping a bleeding by tying a handkerchief over the wound.

Bandaging a Bleeding Wound. — After you have held a wound closed with your fingers or hand for a few minutes, bind it up with

a bandage which will press upon the wound and hold the blood tubes closed. You can make the bandage by crumpling a handkerchief into a ball and tying it snugly upon the wound with another handkerchief.

If several fingers or toes are wounded, or if a whole hand or a foot is injured or cut off, you can stop the bleeding by grasping the whole limb above the bleeding part and holding it tightly so as to close the arteries which carry blood to the wound. In such a wound as this you may not be able to bind a bandage over the wound itself tightly enough to keep the blood from flowing. But you can stop the bleeding by tying a handkerchief or cord tightly around the whole limb above the wounded part.

If a bleeding is very bad you can tie a cord or handkerchief loosely around the limb and make it as tight as you choose by thrusting a stick under it and twisting it. If you



Stopping a bleeding by tying a cord tightly around the limb.

have to do this, watch it carefully, and do not make it any tighter, or keep it on any longer, than is necessary, for the pressure of the cord is both painful and dangerous. Send for a doctor as soon as possible.

Cleanliness of Wounds. — Some persons try to stop

a bleeding place by placing spider webs or other unclean substances over the wound. This is extremely dangerous, for the dust and dirt in them are often full of disease germs. Dirty bandages also contain disease germs. If you have to use a soiled bandage to stop a dangerous bleeding, change it for a clean one as soon as possible. Boiling a bandage will kill the disease germs even if it does not make the bandage look clean.

Sometimes the skin around a wound is dirty, or there is dirt in the wound. Do not try to cleanse the wound, unless you use water which has been boiled. Dress the wound without trying to wash away the blood. The blood itself will be a good dressing, and will help to kill the disease germs which may be in the dirt. Send for a doctor as soon as possible, and let him cleanse the wound.

Nose Bleed. — Blood in a bleeding nose nearly always comes from an open vein. If you have a nose bleed, you can stop it by holding your nostrils closed with your thumb and finger for about five minutes while you breathe through your mouth. This will close the vein and allow the blood to clot in it.



Stopping a nose bleed.

Do not sit bent over while your nose is bleeding, for that will allow a great deal of blood to flow to your head and nose; but sit

up straight to keep the blood away from your head. Do not blow your nose hard for some time after the bleeding has stopped, for that would blow the clot away from the vein and start the bleeding again.

Broken Bones. — When a person has been hurt, try to find out whether or not his bones are injured. A broken bone is not dangerous to life unless it sticks through the flesh, but it is always painful. Sprains, and bones out of joint, are also painful, but not dangerous to life.

You may lessen the pain of a sprain, or of a bone out of joint, by bandaging a stick or thin board to the limb in such a way that it keeps the injured part at rest (p. 74). Then the person may be moved with comfort and safety.

Fainting. — A person who is weak, or sick, or hurt, or frightened, sometimes looks pale, feels dizzy, and falls down and knows nothing for a few seconds. We then say that he has *fainted*. What has happened is that the heart has suddenly become weak and has failed to send blood to the head, and the mind has stopped acting for a moment.

When a person faints, lay him down and keep his head low, so that blood will flow to it. Rub his body, or throw cold water into his face, so as to rouse him. In a moment his heart will begin to beat strongly, and he will soon feel well again.

Fits and Convulsions. — Sometimes a person suddenly falls down, his arms and legs stiffen and shake,

and his face twitches as if he were in pain. We then say that he has a *fit*, or *convulsion*. The stiffness and twitching are caused by contractions of the muscles of the whole body. While a person is in a fit, he knows nothing and does not suffer.

A fit in a grown person is usually caused by a brain trouble called *epilepsy*. While a person is in a fit of epilepsy, almost the only danger is that he may bite his tongue or cheeks. You may prevent this by pressing a handkerchief into his mouth, so as to keep the tongue away from the teeth. You can do nothing to bring a person out of a fit, but in a minute or two the fit usually passes off, and the person feels well again.

A fit in a baby is usually caused by spoiled food in its digestive organs, and usually stops when the cause is removed.

Hysterics. — There is a kind of fit, called *hysterics*, in which a person laughs and cries, and also moves the body as in a real fit. But the person who has it knows what is going on, while in real fits he knows nothing at all. Hysterics are usually caused by fear, or worry. The person who has them acts like a spoiled child that throws itself on the floor, and kicks and cries.

There is no danger from hysterics. Keep yourself calm and cool headed, and act toward the sick person just as you would toward a spoiled child.

QUESTIONS

What is a *panic*?

Of what use are fire drills at school?

Give some reasons why every boy and girl should learn to swim.

Why is it harmful to an injured person for a crowd to gather around him?

What is meant by *shock* when a person meets with an accident?

What should you do for shock?

How can you stop a bleeding wound with your bare hands?

How should you apply a dressing to a wound in order to stop its bleeding?

If an arm or leg is badly wounded, how can you stop the bleeding?

How should you stop a nose bleed?

What harm may dirty dressings do to a wound?

How should you help a person who has a broken bone?

What is the trouble with the circulation of the blood in a person who is in a faint?

How should you help a person who is faint?

What is a fit?

What should you do to help a person who is in a fit?

What is a fit of hysterics?

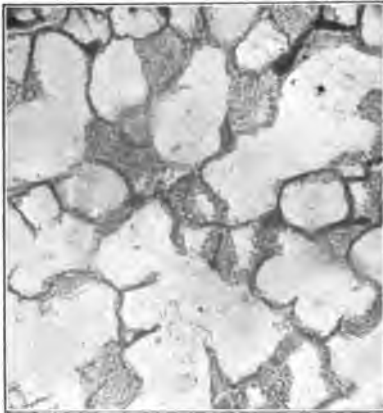
How can you tell hysterics from a real fit?

What should you do for a person who has hysterics?

CHAPTER XI

RESPIRATION

The Lungs. — Every cell in the body must have oxygen in order to live. The oxygen is taken from the air by means of the organs called the *lungs*, and is carried through the body by the blood.

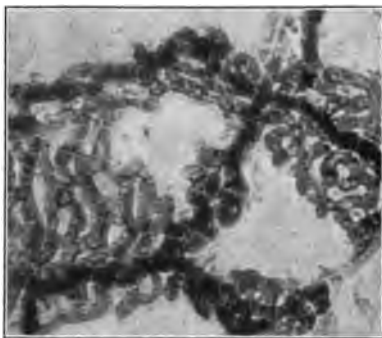


Capillaries and air sacs. *Magnified.*

The lungs are two organs into which air is drawn by the act of breathing. They are composed of millions of microscopic air sacs whose walls are thin, and are covered with capillaries. The red blood cells, passing through the capillaries, take oxygen from

the air in the sacs (p. 89). If the air sacs of the lungs were all opened and spread out, they would cover a surface sixty times as large as the skin on the outside of the body.

Air Tubes. — Air reaches the lungs by passing from the nose and throat through a tube called the *windpipe* or *trachea*. The windpipe begins in a box, called the *larynx*, in which the sound of the voice is made. A lid, called the *epiglottis*, closes over the larynx during swallowing, and helps to keep food from dropping into the windpipe.



Capillaries on air sacs. *Magnified.*

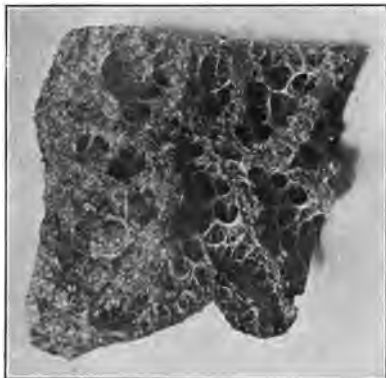


Lung of a frog.

The lower end of the windpipe is divided into two tubes, called *bronchi*, one for each lung. The bronchi divide again and again, and their smallest branches end in the air sacs.

The windpipe and bronchi are lined with mucous membrane, whose glands produce an abundance of thin mucus (p. 25). One of the principal uses of the mucus is to catch dust which may enter the tubes with the air. The substance which is coughed up during a cold is composed mostly of mucus.

The structure of a human lung may be illustrated by the lungs of a frog and of a turtle.



Lung of a turtle.

A turtle's lung is divided into a great number of large air spaces by thin walls which extend in every direction through the lung. Each air space is like an enlarged air sac in a human lung.

Cilia. — The mucous membrane of the bronchi is lined with short threads of flesh which stand up from the epithelial cells, like the threads upon velvet cloth (p. 25). These threads are called *cilia*.

They wave swiftly back and forth, and help to force the mucus from the tubes. In this way they keep

A frog's lung is a thin-walled sac, about the size of the last joint of a person's finger. Its inner surface is marked off into shallow spaces with low partitions over which arteries and capillaries run. The whole lung is like a single air sac in a human lung greatly magnified.



Cilia.

the bronchi clean, and prevent dust from entering the air sacs.

The Chest or Thorax. — The hollow space in the upper part of the trunk of the body is called the *chest*, or *thorax*. Its back wall is formed by the backbone, its sides by the ribs, and its front side by the breast-bone, or *sternum*. Its bottom is formed by a sheet of muscle, called the *diaphragm*, which extends across the body in the form of a dome at about the level of the waist. The chest contains the lungs and the heart.

Breathing. — The ribs are joined together by flat muscles, called the *intercostal*, or rib, muscles. When the muscles contract, they raise the outer ends of the ribs, and increase the size of the chest. When the diaphragm contracts, it flattens its arch, and also increases the size of the chest.

The air sacs of the lungs are always filled so full of air that the sides of the lungs are kept pressed against the ribs and diaphragm. When the chest increases in size, air rushes into the lungs, and when the chest muscles relax, the chest becomes smaller, and forces some of the air out of the lungs. The passage of air into and out of the lungs is called *breathing*. Taking air into the lungs is called *inspiration*, and forcing air out of the lungs is called *expiration*. A person usually breathes from fifteen to twenty times each minute.

How Cells Breathe. — While blood is passing through the lungs, its red blood cells take up oxygen from the air sacs. The blood then goes back to the heart, and

then through the arteries to all parts of the body. When it reaches the capillaries, it gives up the oxygen to the cells.

The cells in all parts of the body use oxygen to oxidize both their own substance, and also the food which they receive from the blood. One of the principal substances which the oxidation produces is carbon dioxide (p. 32). The blood takes up the carbon dioxide and carries it through the veins, back to the heart, and to the lungs, and gives it off to the air sacs. It then passes out from the body with the breath of the next expiration.

Summary of the Changes produced by Breathing. — During inspiration, the lungs receive oxygen. During expiration, the lungs give off carbon dioxide.

The air sacs of the lungs give oxygen to the blood, and receive carbon dioxide from it.

In the lungs the blood takes oxygen, and gives off carbon dioxide.

In the capillaries of the body blood gives off oxygen and takes up carbon dioxide and other waste substances.

The cells of the body take oxygen from the blood, and give carbon dioxide and other oxidized substances to it.

Breathing and Health. — The strength of the body comes from the oxidation in it (p. 32). When you sit still and do not breathe much oxygen into your body, or when you eat more food than you can oxidize, the oxidation in your body takes place in an imperfect manner, and the waste substances produced by the

oxidation are more poisonous than they should be (p. 33). You then feel dull, stupid, and weak. You can neither think clearly, nor do good work with your muscles. Your blood cells will not easily destroy disease germs which may enter your body, and you will take diseases readily.

When oxidation takes place in a perfect manner, you feel bright and active, you enjoy your work and play, and your body easily protects itself against diseases. Breathing properly is one of the best means of keeping yourself in good health.

Shortness of Breath. — When you take exercise, you use up a great deal of oxygen in supplying your muscles with power and warmth (p. 81). When you exercise hard, your blood may not be able to carry oxygen so fast as your muscles use it. You then feel short of breath and cannot breathe deeply enough, or often enough, to supply your muscles with all the oxygen that they need. The first sign that your strength is failing is nearly always a shortness of breath.

You can increase your strength and endurance, as well as your health, by doing those things which will help your blood to take up a great deal of oxygen. The principal ways of doing this are by practicing deep breathing and by taking exercise. In these two ways you can take a large amount of oxygen into your body, and you can also cause oxidation to take place in a perfect way (p. 83).

Deep Breathing. — When you take brisk exercise,

you soon feel short of breath, and cannot help breathing deeply and taking a large amount of air into your lungs. One of the greatest benefits from exercise is that it compels you to breathe deeply.

If you have to sit at a desk all day, and have but little time for exercise, you can increase the oxidation in your body by taking deep breaths often. When you begin to feel dull, sit up straight, take a deep breath, and hold it as long as possible. This will stretch the air sacs of your lungs wide open, and will fill them with a large amount of oxygen which the blood will carry through every part of your body.

Most lung diseases are caused by disease germs which enter the lungs with impure air. If the lungs do not receive a large quantity of air, the disease germs will lie quietly in the air sacs and the smaller air tubes, and will grow there undisturbed. But deep breathing will stir up the germs, and drive them out of the lungs. The movements of breathing will cause the blood to flow freely among all the air sacs where its white blood cells will destroy the disease germs which may enter the sacs. Deep breathing is one of the best of all means for preventing lung diseases.

Alcohol and the Lungs. — The air tubes and lungs receive more disease germs than most other parts of the body. The stomach can protect itself against disease germs which are swallowed, for its digestive juices destroy the germs. But the lungs have only the white blood cells for protection against the germs.

Alcohol in the blood weakens the white blood cells and prevents them from destroying disease germs. The use of alcohol is therefore harmful to the lungs. Drinkers are more likely to have diseases of the lungs than those who do not take strong drink. Whisky, wine, and beer do not help a person who has a cold, but they make the cold worse.

Tobacco Smoking. — When tobacco is burned, some of its nicotine is turned to vapor and is drawn into the mouth. When the smoke is blown from the mouth, some of the nicotine remains behind, and is swallowed. It then enters the blood, like food that is swallowed. Tobacco smoke also contains other harmful substances besides nicotine.

The smoke from a cigar usually contains less nicotine than that from a pipe, and smoke from a cigarette contains still less, for the fire on the cigarette is hotter and burns up more of the nicotine than the fire on a cigar or pipe. But those who smoke cigarettes often draw the smoke into their lungs and blow it from their noses. When a person smokes a cigarette in this way, he usually takes more nicotine into his blood than he does when he smokes a cigar or a pipeful of tobacco. The smoke from a cigar or pipe has a stinging taste and smell, and few persons care to draw it into their lungs to blow it through their noses. Cigarette smoke is more harmful than smoke from a cigar or pipe, because it has less of a stinging taste or smell, and the smoke seems the more pleasant, when really it is the more dangerous.

QUESTIONS

What are the *lungs*?

What is the *larynx*? the *trachea*?

What are the *bronchi*?

What are *cilia*?

What is the *diaphragm*?

How does a person make air pass into and out of the lungs?

How does oxygen pass from the lungs to the cells of the body?

What do the cells of the body do with the oxygen which they receive?

Of what use is oxidation?

How can you increase the oxidation in your body?

How does exercise of the muscles help the oxidation in the body?

What is the cause of shortness of breath?

What good effects are produced by practicing deep breathing?

How does deep breathing help the lungs to destroy disease germs?

What effect does alcohol have upon the lungs?

What becomes of the nicotine of tobacco when a pipe, cigar, or cigarette is smoked?

Why is cigarette smoke usually more harmful than smoke from a cigar or pipe?

CHAPTER XII

HINDRANCES TO BREATHING

Stooped Shoulders. — If you allow your shoulders to fall forward, their weight and the weight of your arms will press upon your chest, and you will be unable to breathe freely. Take as deep a breath as you can while you sit with your shoulders bent forward and resting on your chest. Then throw your shoulders back and see how much more air you can take into your lungs.

When you sit up straight, the muscles of your back will hold your shoulders up, and will also help to raise the ribs when you take a deep breath. When you bend over your work, do not let your shoulders fall forward on your chest. Keep them thrown back and your elbows at your side. You will then be able to breathe freely, even though you have to bend forward while you work.

Tight Clothing. — If your clothing is tight, you cannot move your chest freely, and cannot breathe deeply. Half of the movements of breathing are done by flattening the diaphragm and moving the parts of the body below the waist line. Girls who lace their waists tightly interfere with their breathing almost as much as they would if they should lace their chests.

Measurement of Breathing. — There are two easy ways of measuring the quantity of air which you take into your lungs. One way is by passing a tape measure around your chest under your arms and noting the size of your chest before taking a breath, and again after taking it. An expansion of three inches is large for a twelve-year-old boy. An expansion of less than two inches is too little for him.

Another way of measuring the air which you breathe is to fill a large glass jar with water and turn it upside down in a shallow pan of water in such a way that the water remains in the jar. Then pass a rubber tube under the water, into the jar, and blow through it. As air enters the jar, the water passes out. By measuring the distance the water sinks in the jar you can tell how much air you breathe out from your lungs.

When a man sits still at a desk and breathes quietly, he expands his chest about half an inch, and inhales about thirty cubic inches, or a pint of air with each breath. When a strong man takes a very deep breath, he expands his chest four or five inches, and inhales from two to four quarts of air.

A single deep breath of air will last your body less than a minute. You cannot store oxygen in your body, for you use it up as fast as you breathe it, and must take it into your body at the moment when you make use of it. Your strength and endurance will depend on how much oxygen you can take into your body. If you can expand your chest only an inch, and can take

only a quart of air at a full breath, you will not be strong and healthy. If you take exercise, and practice deep breathing, you will soon be able to expand your lungs three or four inches. Your body will then receive an abundance of oxygen, and you will be strong and long winded.

Mouth Breathing.—The lining of the nose is crumpled into folds, and is moistened with mucus. As air passes over the folds, it is warmed and moistened, and most of the dust and disease germs which may be in it are caught in the mucus. When the breath passes through the mouth, the air enters the lungs cold and dusty. Mouth breathing is harmful to the lungs, and is the cause of a great deal of ill health.



Folds of bone in the nose of a calf.

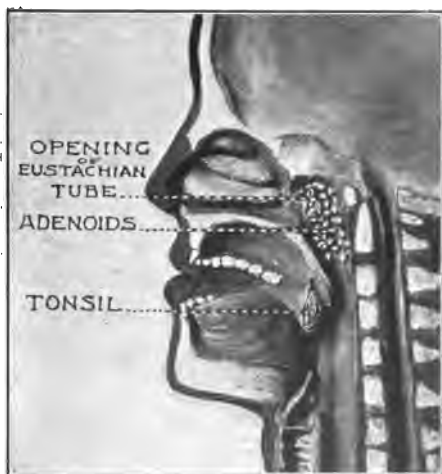
Every person will naturally breathe through his nose if it is clear and open. If he breathes through his mouth, it is because his nose is partly stopped up. A stopped-up nose always feels uncomfortable, and breathing through the mouth requires an effort. A child at school cannot put his mind upon

his lessons if he has to think about his breathing every moment.

Your nose may be stopped up with mucus. If this is so, remove the mucus by blowing it out.

If your nose remains stopped up after blowing it lightly two or three times, the stoppage is probably caused by a swelling of its lining. This swelling is usually due to an extra amount of blood in the nose. Blowing the nose hard will send more blood to it, and will make its swelling worse. You can make the swelling go down by blowing out all the breath that you can, and then waiting as long as you can before you take

another breath. The chest, in trying to expand, will draw blood away from the head. The blood tubes of the nose will then be emptied, and the swelling of the lining will go down.



Model of the nose and throat.

Adenoids.— Mouth breathing is often caused by masses of soft flesh,

called *adenoids*, growing in the back part of the throat behind the nose. Children who hold their mouths

open while they breathe, and who snore in their sleep, nearly always have adenoids. What is called *catarrh* is usually due to adenoids. They are often the cause of colds, sore throats, and deafness. They may be removed as quickly, safely, and painlessly as a tooth may be pulled. Their loss does not produce any bad effects, for they are of no use to the body. A person



Adenoids and enlarged tonsils removed from a three-year-old boy.

from whom they are taken out is left in the same state as one who has not had adenoids at all. After a child has had his adenoids removed, there is nearly always a remarkable improvement in his health, strength, and appearance.

Enlarged Tonsils. — Two round masses of flesh, about the size of black walnuts, may extend from the sides of the throat and almost meet over the back of the tongue. These masses are called *enlarged tonsils*. They interfere with breathing and speaking, just as if marbles were held in the throat. They are nearly always full of holes in which disease germs often lodge and grow, producing the bad form of sore throat called *tonsillitis*. Those who have enlarged tonsils nearly

always have adenoids. The tonsils may be removed as easily and with as much benefit as adenoids.

Artificial Respiration. — A person who has been nearly drowned may be brought back to life by causing air to pass into and out of his lungs, as in natural breathing. Causing a person's chest to move in imitation of natural breathing is called *artificial respiration*.



Artificial respiration. Inspiration. Drill by the crew of a U. S. Life Saving Station.

If you know how to do artificial respiration, you may be able to save the life of a drowning person when no one else is near (p. 108).

One of the best ways of doing artificial respiration is to lay the drowned person on his back, grasp his arms near his elbows, and press them hard against his chest. This produces expiration. Then carry the arms straight out above his head. This raises his chest and draws air into his lungs. Make these movements about as often as you naturally breathe. Do not stop

if life does not return within a few moments. Drowned persons have been saved after artificial respiration has been done on them for over an hour.



Artificial respiration. Carrying the arms forward in expiration.

While you are doing artificial respiration, it will be a good plan to have some one assist you by pulling the



Artificial respiration. Lifting the body to let the water run from the lungs.

drowned person's tongue forward every time you carry the arms above his head. This will help to open the windpipe.

There will be some water in the lungs of a drowning person. Every few moments turn him on his face and lift his body by grasping the chest just back of his shoulders, so as to let the water run from his mouth. But do not stop doing the artificial respiration for more than a few seconds at a time.

Practice doing artificial respiration on each other, so that you will know how to do it if you are ever called to help save a drowning person.

Electric Shock. — If a person has received a strong shock of electricity, his life is in danger because he cannot breathe. You may be able to save his life by doing artificial respiration.

Alcohol and Oxidation. — Alcohol will readily unite with oxygen and will burn with a hot flame. An alcohol lamp burns alcohol which is drawn up a cotton wick. The wick hardly burns at all, for oxygen unites with the alcohol instead of the cotton of the wick.

When alcohol enters the body, it becomes oxidized quickly, and uses up the oxygen which would otherwise oxidize food and flesh. If the proper food is not oxidized, the body will suffer. The use of alcohol deprives the body and its food of oxygen and produces the same harmful effects that breathing too little oxygen will produce.

QUESTIONS

How do stooped shoulders interfere with breathing?

How does tight clothing interfere with breathing?

How many inches should a twelve-year-old boy be able to expand his lungs?

About how many pints of air can a strong man take into his lungs with each breath?

How long will a deep breath of air last the body?

What harm comes from breathing through the mouth?

What are three common causes which prevent a person from breathing through the nose?

How can you cause your nose to become open when it is stopped up?

What are *adenoids*?

What harm do adenoids do?

How can you get rid of adenoids?

What are *enlarged tonsils*?

What harm do enlarged tonsils do?

How can you save the life of a drowning person?

Describe how to do artificial respiration.

What would you do for a person who has received a bad shock of electricity?

What effect does alcohol have on the oxidation in the body?

CHAPTER XIII

FOUL AIR

Composition of Fresh Air. — Outdoor air is made up of about one fifth oxygen and four fifths nitrogen. About one hundredth of it is vapor of water, and one twenty-five hundredth is carbon dioxide. A few bacteria, and some particles of dust are nearly always floating in it. All these substances enter the nose and air tubes during breathing.

Oxygen is the part of the air which supports life and oxidation. When the end of a red-hot iron wire is thrust into a jar of oxygen, the wire burns like a match, and throws off a shower of sparks. If a stove were set up in a room full of oxygen, its iron would burn up if a fire were started in it. If we should breathe pure oxygen, the oxidation in our bodies would take place too rapidly for health. The effect of the nitrogen of the air is to dilute the oxygen, and make it act in a mild way.

Composition of Expired Air. — Oxygen forms about one fifth of the air which is taken into the lungs during breathing, but it forms only about one sixth of the air which is breathed out from the lungs. The difference between one fifth and one sixth, or one thirtieth, stands

for that part of the air which enters the blood while a breath remains in the lungs.

Since the amount of air in a quiet breath measures about thirty cubic inches, and one thirtieth of it goes into the blood, the amount of oxygen which enters the blood with each breath measures about one cubic inch.

Carbon dioxide forms a very small part of outdoor air, but it forms about one thirtieth of the air which is breathed from the lungs. Thus the amount of carbon dioxide which leaves the lungs with each breath is about one cubic inch.

Expired air is loaded with vapor of water, and contains a small quantity of poisonous substances which give it a bad odor. It is usually warmer than inspired air.

SUBSTANCES AND QUALITIES OF THE AIR	INSPIRED AIR	EXPIRED AIR
Nitrogen	$\frac{1}{5}$	$\frac{1}{5}$
Oxygen	$\frac{1}{5}$	$\frac{1}{5}$
Carbon dioxide	$\frac{1}{3000}$	$\frac{1}{30}$
Moisture	Usually dry	Very moist
Odor	None	Considerable
Warmth	Usually cool	Warm

Table showing the changes produced in the air by breathing.

When the air contains less than one sixth oxygen, an animal cannot live in it, and it cannot support the burning in a fire. Air that comes from the lungs can-

not support either life, or a fire. A fire will often burn brightly when a person blows his breath upon it, but this is because he then takes deep breaths, and blows the air out before his lungs have time to take the oxygen from it.

Wrap the end of a wire around a piece of candle. Light the candle, and lower it by the wire into a jar holding about a pint. It will burn about ten seconds, and will then go out.



Experiment. Lowering a burning candle into a jar.

Take a few deep breaths and quickly blow the last breath into the jar, as if you were blowing a fire. A lighted candle will now burn in the jar nearly as long as in the jar filled with pure air.

Take a deep breath, hold it for ten seconds, and blow it into the jar. A lighted candle will then go out as soon as it is lowered into the jar, for the air loses a large part of its oxygen while it remains in the lungs.

Why the Outdoor Air stays Pure. — Since fires and animals are always using up oxygen and pouring car-

bon dioxide into the air, we might suppose that the outdoor air would finally become impure. It does not do so for two reasons: first, the winds carry the impurities away and bring in fresh air, and second, plants take carbon dioxide from the air and use it as food. Their green leaves separate the oxygen from the carbon. They give the oxygen back to the air, and use the carbon in building up their stems, roots, fruit, and other growing parts. The quantity of oxygen which plants give to the air nearly balances the amount of carbon dioxide which animals and fires pour into the air.

Many persons suppose that plants growing in a room will purify the air. Plants really have little effect on the air of a room. Probably the quantity of carbon dioxide and other injurious gases which pass off from the soil of the flower pots is greater than the amount of oxygen which passes off from the leaves of the plants.

Composition of Foul Air. — When a person is in a closed room, each breath takes away some oxygen from the air, and puts carbon dioxide in its place. Breathing also warms the air and increases the amount of water and of foul-smelling gases which are in the air. How much the breathing will change the air will depend on how many persons are in the room, how long they stay in it, and how tightly the room is closed.

Effects of Foul Air. — When a person breathes the air of a room over and over again, he has a headache, and feels dull and short of breath. If the air becomes

very foul, he feels dizzy and faint. These feelings are due partly to the increased quantity of carbon dioxide in the air, partly to the lack of oxygen, partly to foul-smelling substances, and partly to the increased moisture and warmth of the air. But most of the bad effects which foul air has upon the health of the body are caused by the dust and disease germs which are usually found in foul air.

When the air of a schoolroom begins to be foul, the bad effects on everybody in the room quickly appear. The scholars cannot put their minds to their work, or think clearly. Scholars often fail in their lessons because they are compelled to breathe foul air while they study.

Breathing foul air day after day has a bad effect on the whole body. Many persons are weak, pale, and sickly, because they breathe foul air during some part of the day or night. Fresh air, full of oxygen, and free from the poisons of the body, is necessary for health and strength.

You cannot enjoy perfect health and strength unless you always breathe fresh air. A few moments of fresh air two or three times a day will not be enough. You need it every moment, both night and day.

The air of a room begins to be noticeably foul when the amount of its carbon dioxide is doubled. When its carbon dioxide is increased to four or five times the amount that is in outdoor air, the air is too foul for breathing. The air of crowded meeting places is

often so foul that it contains ten or fifteen times as much carbon dioxide as outdoor air.

Disease Germs in Foul Air. — If a person has a cold, or tonsillitis, or diphtheria, or other disease which is catching, he will expel disease germs with tiny drops of saliva and mucus from his nose and throat when he coughs, or talks, or sneezes, or blows his nose. The drops quickly dry, and their germs rise with the dust of the room and float in the air. They may then enter the bodies of other persons with their breath. Millions of germs fly off from every dried collection of mucus which is spit upon a floor or pavement.

Wherever many persons meet together, some one who has a cold or other infectious disease is likely to be in the room. For this reason the foul air of houses and meeting places nearly always contains disease germs. A common way in which a cold, or a sore throat, or pneumonia, or consumption, is caught is by breathing air which has been made foul by some one who has the disease.

Each pint of foul, dusty air of a crowded room or meeting place may contain fifty bacteria, and many of them are likely to be disease germs. Less than five bacteria may usually be found in a pint of outdoor air from a dusty city street, but if the day is still and the streets are wet, the outdoor air will contain almost no bacteria at all.

It is almost impossible for you to catch a disease by breathing outdoor air. If you keep a room supplied

with outdoor air, you will not catch a cold or any other disease from the air, for there will be no disease germs floating in it.

How to Tell Foul Air. — An easy way of telling whether or not the air of a room is foul is by its smell. When the amount of carbon dioxide in the air has been doubled by breathing, there will be enough waste matters breathed from the lungs to give the air an unpleasant smell. An odor of foul air that you can notice at all is a sign that the air is unfit to breathe, and that it is likely to contain disease germs.

Some persons think that the smell of foul air comes from dirty clothes, or from a dirty skin. Dirt makes the smell worse, but the greater part of the odor comes from the inside of the body. Foul air in the houses of persons who are clean and educated has the same smell as foul air in the houses of those who are ignorant and dirty.

After breathing foul air for a few moments, you may become used to the smell, and may no longer notice it; but the air is then as dangerous as ever. If you are not sure about the freshness of the air of your room, step out of doors for a moment. If you can notice an unpleasant smell in the air when you come back to the room, the air is foul and unfit for breathing. Then change the air for fresh air from out of doors.

Vapor of Water in Foul Air. — Expired air contains nearly all the vapor of water that it can hold. When the air is cold, the vapor in the breath looks like

steam. Air which has been made foul by breathing is loaded with vapor which comes from the lungs. This vapor increases the bad odor of the air and the unpleasant feelings which are produced by the foul air. If the windows of a crowded room are wet with vapor which is produced by breathing, that air is too foul to be breathed with safety.

Reckoning when Air will become Foul. — If you were shut in a tightly closed room which measures 10 feet square and 10 feet high, how long could you remain in the room before the air would become unfit to breathe?

The room would contain 1000 cubic feet of air. Since $\frac{1}{2500}$ of fresh air is carbon dioxide, the amount of it in the room would be $\frac{1000}{2500}$ of a cubic foot, or 691 cubic inches. If another 691 cubic inches of carbon dioxide were breathed into the room, the air would be noticeably foul. Since you give off about one cubic inch of carbon dioxide with each quiet breath, and breathe about twenty times a minute, it will take you $\frac{691}{20}$ minutes, or about half an hour, to make the air unfit for use. The problem shows that a person breathing quietly causes 1000 cubic feet of fresh air to become foul in half an hour. It also shows that each person requires at least 2000 cubic feet of fresh air each hour. A person taking exercise will require two or three times that quantity of fresh air.

If you should sleep in an ordinary bedroom with your doors and windows closed, the air would be unfit

to breathe within an hour, and in the morning you would wake up dull, and weak, and faint. If a person who has a cold should sleep in the same room with you, the air would contain many disease germs which are given off from his nose and throat during the night, and you would be very likely to catch the sickness from him.

Suppose a schoolroom is 30 feet square and 10 feet high, and has 30 scholars in it. The quantity of air will be only 300 cubic feet for each scholar, and it will be unfit for breathing in less than an hour, unless it is changed for outdoor air. A single scholar who is coughing and sneezing will soon give off a dangerous number of disease germs if the foul air is allowed to remain in the room.

QUESTIONS

Of what substances is the outdoor air composed?

Of what substances is expired air composed?

Of what substances is foul air composed?

How much oxygen does a person take from the air with each quiet breath?

How much carbon dioxide does a person give off with each quiet breath?

How much oxygen must there be in the air in order to support a man's life?

How can you show that the expired air of quiet breathing will not support the burning in a fire?

What is the difference between the breath when a person blows a fire, and the expired breath of his quiet breathing?

What becomes of the impurities which are breathed into outdoor air?

What are the effects of breathing foul air?

How does foul air spread diseases?

How can you detect foul air?

How can you reckon how much fresh air a person needs each hour?

If the windows and doors of an ordinary bedroom were closed, how long would the air remain pure if one person were sleeping in the room?

If no fresh air were let into your schoolroom and if it were full of pupils, how long would the air in it remain fit for breathing?

CHAPTER XIV

VENTILATION

Need of Ventilation. — Exchanging the impure air of a room for air which is pure and fresh is called *ventilation*. A small room will require a complete change of air within an hour if only one person is in it. A large room will require a complete change of air within a few minutes if many persons are in it. A school-room, church, or other meeting place needs to be ventilated all the time that it is in use, for the air will become unwholesome within a few moments, unless a stream of fresh air is constantly flowing into it. Each person requires at least 2000 cubic feet of fresh air every hour (p. 141).

How to Ventilate. — Some air will pass into and out of a room through cracks in its doors, windows, floor, and walls. Well-built houses have few cracks, and only a little fresh air will enter them, unless openings are made to the outdoor air.

One way of ventilating a room is to open a window. This is often the only way to get fresh air into a room. It is easy to ventilate a room that is heated. Warm air is lighter than cold air, and will rise to the ceiling, like a cork on water. When the upper sash of a window

is lowered, a stream of foul air passes out above it. Fresh air enters the room between the two sashes, and through cracks in the other parts of the room. If foul

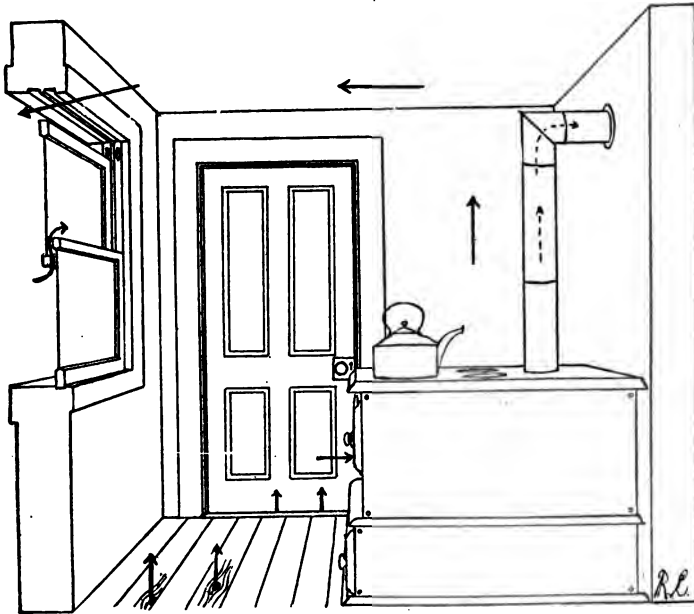


Diagram of ventilation.

air passes out of the room, we may be sure that other air enters the room.

When the lower sash of a window is raised, foul air sometimes passes out through the opening, and sometimes fresh air blows into the room through the opening, but whether the foul air blows out, or fresh air blows in, the air of the room becomes changed.

Ventilators. — Many houses, schools, churches, and

other meeting places have openings in the ceilings leading to attics, or to large pipes which open above the roofs like chimneys. These openings carry off the foul air, while fresh, cool air enters through the doors and windows.

In large buildings, fans are often placed in the basements to force fresh air through the rooms. In this way the amount of air sent into the room may be regulated, and the air of the room may be kept perfectly pure.

Ventilating Bedrooms. — Some persons think that a bedroom does not need to be ventilated during the night if it is aired well during the daytime. A person sleeping in a small, closed bedroom will cause the roomful of fresh air to become foul within an hour after he goes to bed. He will then breathe foul air through all the rest of the night, unless he ventilates the room.

Many suppose that a person will not be harmed by breathing air which he himself has made foul. Impure air is as poisonous to the person who makes it foul as it is to another person who may breathe it.

The Arithmetic of Ventilation. — If twenty persons are in a room, how wide should the windows be opened in order to keep the air of the room fresh?

The quantity of fresh air which should enter the room each hour is at least 40,000 cubic feet, whether the room is large or small, for each person needs 2000 cubic feet of fresh air each hour (p. 141).

A gentle current of air that barely shakes a curtain will move about four feet a second, or about as fast as a man walking rather slowly. If air flows at that rate through a window three feet wide, which is opened four inches, four cubic feet will pass through the opening in one second, 240 cubic feet in a minute, and 14,400 cubic feet in an hour. Therefore, three windows will have to be kept open four inches in order to supply the 40,000 cubic feet of air per hour which twenty persons need. If the air currents move rapidly enough to make a cold draft across the room, or to blow the curtain aside, smaller openings may supply a sufficient quantity of fresh air. If the outdoor air is warm and still, larger openings will be required.

Drafts. — Many persons do not ventilate their rooms and meeting places during cold weather because they fear that drafts will produce the forms of sickness called colds. A cold is caused by disease germs which come from other sick persons, just as measles come from germs which another person gives off from his body. If a person gives off the germs of a cold to the air of a room, any one who breathes the air will take the germs into his nose and throat, whether there is a draft in the room or not. The time to open a window and to begin to ventilate is as soon as any one comes into a room, and before the air becomes foul. If the air of a room is pure and fresh, there will be no disease germs in it and a person will not catch a cold from breathing the air.

It is nearly always possible to ventilate a room without producing drafts. One way is to drop the upper sashes of the windows on the side of the room which is opposite to that on which the wind blows. The main stream of air will then flow out of the room, and fresh air will enter in many small streams through cracks in the doors and windows.

Another way to prevent a draft while ventilating a room is to tack a sheet of thin muslin to a frame and place it in an open window as you would a mosquito screen. This will allow fresh air to enter the room, but will prevent it from blowing across the room in a draft.



Dust as seen under a microscope.

Dust. — Any kind of dust is harmful, and those persons who work in dusty air are more likely to catch lung diseases than those who work in the open air. Bronchitis and consumption are common among tool grinders, for they breathe sharp particles of steel which are ground from the tools.

Dust in Foul Air. — The air of living rooms and meeting places is nearly always dusty. The dust consists of soil, ashes, bits of skin from the body, and

shreds of wood, cotton, and wool. These substances may not do a great deal of harm, for the mucus of the nose and throat usually catches them and prevents them from reaching the lungs.

Bacteria in Dust. — House dust also contains many kinds of bacteria and spores of molds (p. 37). Many of the bacteria are those which have come from the bodies of persons, and often they are the bacteria of diseases. These kinds of bacteria are dangerous, for they may multiply rapidly in the nose, throat, and air tubes, and produce diseases in those who breathe them. One of the principal reasons why foul air is dangerous is that persons who breathe the air stir up dust and disease germs from the floors, carpets, and furniture. If a room is clean, only a little dust and very few bacteria will rise into the air. Keeping a room well swept and dusted will prevent a great deal of sickness.

Sweeping and Dusting. — While you are sweeping a room, open its doors and windows so that the dust will be blown away. When you dust the furniture, use a moist cloth so that it will hold the dust and not scatter it through the air again.

Sweeping will not remove all the dirt from carpets which are tacked down to the floor, for a broom will remove only the dirt which is on the surface, and will not take out the dirt and dust which lie among the threads, or under them. Rugs are more healthful than carpets, for they may be taken up and cleaned.

A vacuum cleaner is an excellent thing for cleaning carpets and cushions, for the dirt and dust are forced up from among the threads, and held in a tight box from which they cannot escape into the air.

A floor which is varnished or painted is hard and smooth, and dust and dirt may be easily removed from it. The floors of schoolrooms and other meeting places are likely to be worn and soiled by the feet of many persons walking across them. Oil is an excellent thing for these floors, for it will help to harden the floors and will prevent dust from rising from them.

Sunshine in a Room. — Disease germs will often stay alive for days and weeks in dark, damp corners of rooms and closets, but sunlight will dry a room, and will also kill the disease germs which may be in it. Sunlight, cleanliness, and fresh air are the best of all means for making a room healthful.

Many old houses have rooms which do not have a single window opening into the outside air. These rooms are breeding places of disease, for they receive neither light, nor fresh air. Most cities now have laws that every room in a house shall have windows opening into the outside air. There are also laws that large air shafts shall be left open between crowded buildings, so that every room may get air and light.

QUESTIONS

What is ventilation ?

How much fresh air does each person need in an hour ?

How can you ventilate a room ?

How does heating a room help to ventilate it ?

When should you begin to ventilate a room in which a crowd gathers ?

How rapidly may a current of air move through a window without making a strong draft ?

How can you reckon how wide to open the windows of a room in order to ventilate it properly ?

How can you prevent a draft in a room while ventilating it ?

Of what does dust in houses consist ?

What harm may come from breathing dusty air ?

How should you sweep and dust a room ?

Why is a vacuum cleaner an excellent machine to use for cleaning a room ?

How does painting a floor help to make a room healthful ?

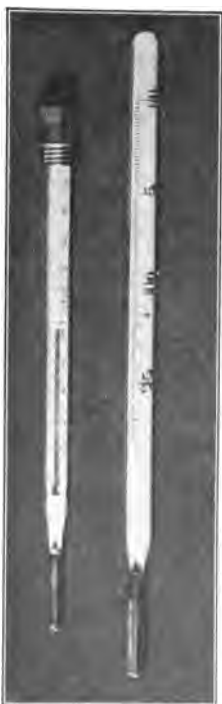
Why are rugs more healthful than carpets ?

How does sunshine help to make a room healthful ?

Why do cities have laws regulating the number of windows in a room ?

CHAPTER XV

BODY HEAT



Thermometers for taking the temperature of the body.

Source of Heat in the Body. — The body is warmed by the oxidation of its food and flesh. A large part of the oxidation takes place in the muscles. Exercise makes a person feel warm, for oxidation takes place rapidly when the muscles are in use (p. 81). When a person sits still, oxidation goes on slowly, and he feels cool.

Thermometer. — The warmth of an object is called its *temperature*. It may be measured by means of a *thermometer*. The kind of thermometer which is in common use consists of a glass bulb blown upon the end of a small glass tube, and filled with mercury. Heat causes the mercury to expand and rise in the tube. The tube is marked with degrees, and by reading the mark at which the mercury stands we

can tell the temperature. The letter F. after a degree figure shows that the marking called the *Fahrenheit* scale is used. In this scale a freezing temperature is marked 32° , and the temperature of boiling water 212° .

Temperature of the Body. — If you should place a thermometer in the mouth of a healthy person, you would find that it shows a temperature of very nearly 98.5° F. If you should bury the thermometer in his flesh, it would still show nearly the same temperature.

Some parts of the body, such as the ears and fingers, produce very little heat, and yet they too have a temperature of 98.5° F., unless the air is very cold. The blood keeps the temperature of all parts of the body at nearly the same degree of warmth, for its stream is so large and swift that it warms the cooler parts, and cools the warmer parts.

Fever. — A body temperature which is a degree or more warmer than 98.5° F. is called a *fever*, and is a sign of sickness. If the temperature is 101° F., a person usually feels sick and weak. If it is 104° F., he is dangerously sick. A fever is nearly always caused by disease germs growing in the body.

Feeling of Warmth. — You cannot always tell the temperature of your body by your own feelings of warmth. This is because most of the nerves by which you feel warmth are in your skin. If your skin is cold, you seem to feel cold all through your body, no matter what the temperature of the inside of your body may be. At the beginning of a fever your skin will some-

times be pale and cold from lack of blood. You will then feel cold, even though a temperature of the inside of your body may be 102° F., or more. A feeling of cold during a fever is called a *chill*.

Regulation of Temperature. — The temperature of your body does not change more than half a degree while you are healthy. . If you are well and strong, it stays at 98.5° F., whether you feel too warm after running, or are shivering in a cold wind. The principal way in which the body regulates its temperature is by getting rid of the heat which it does not need.

A great deal of the heat which the body loses passes into the air which touches the skin, for the air is nearly always cooler than the body. When a large quantity of heat is produced, as by hard exercise, the arteries of the skin become large and bring a great amount of blood near the cool air. On a hot day the skin is red and full of blood, for it is trying to throw off heat. On a cold day the skin is pale, for its arteries contract and keep the blood away from the cold air which would cool the blood too rapidly (p. 91).

If your hands are cold, you can warm them by rubbing or clapping them around your back so as to make a large quantity of warm blood flow through them.

Perspiration and Heat. — On very warm days and in hot places, the air may be warmer than the skin. Still the body does not usually become warmer than 98.5° F., for the perspiration in drying takes the heat away from the body. The perspiration is the principal

means by which the temperature of the body is prevented from rising on hot days, and during hard exercise.

Sunstroke. — If blood does not flow freely through the skin on a hot day, a person may not perspire, and then his body may become too warm. The heat may make him weak, and we then say that he has a *sunstroke*.

When a person has a sunstroke, his skin may be pale and cold, but the inside of his body will be too warm. Lay him down in a cool place, and rub his skin with cold water. This will make the blood flow through the skin, and will cool the body.

Clothing. — Heat passes off from the body very rapidly when the air is cold. If the temperature of the air is below 70° F., clothes will be needed in order to prevent the heat from passing off too rapidly. Clothes do not make heat: They keep the body warm by preventing the air from taking heat away from the skin. If the temperature of the air is 70° F., or warmer, the body can regulate its own temperature without the help of clothes.

If the layers of cloth in a suit of clothes were pressed into a firm sheet, they would not keep the body warm, for they would allow the heat to pass through them readily. But if they are made up of loose fibers and layers, the air which is in them prevents the heat from passing off. For this reason a number of thin garments are warmer than a single thick one; cloth which

is soft and loosely woven is warmer than that which is hard and tightly woven; and garments which fit loosely are warmer than those which fit tightly.

Woolen cloth is warm because it is usually soft and loosely woven. Cotton or linen cloth which is soft and loosely woven is nearly as warm as wool, but when it is washed, it often becomes hard and firm. It does not then protect the body from the cold so well as woolen cloth.

Wet Clothing. — If clothes are wet, the heat of the body causes the water to dry from them. The vapor then takes away the heat and makes the body feel cold. Damp clothes are harmful when they cool the body. They will not usually harm the body during exercise, for the exercise will keep the body warm. They are harmful when a person sits still, for they may then cool the body more rapidly than heat is produced.

Taking Cold. — It used to be supposed that coldness was the cause of the kinds of sickness which are called *colds*. We know that colds are caused by disease germs which come from foul air, and from dust and dirt. There are no more disease germs in air which is cold and damp than in air which is warm and dry. On days which are cold or damp people keep their doors and windows closed, and the air of their houses becomes foul and full of disease germs (p. 139). They then catch cold by breathing the foul air when they go into the house to warm and dry themselves. Coldness

and chills will not make a person take cold unless he also takes living germs of the sickness into his body.

There is a way in which coldness may help a person to catch cold when he takes disease germs into his body. Cold air blowing upon the body may weaken it so much that the white blood cells cannot destroy disease germs when they enter the body (p. 90). If the body is chilled, it may not be able to destroy disease germs which it is usually able to overcome. But there must be disease germs in the body before a cold can develop. Remember also that disease germs in the body may cause a cold whether the body has been chilled or not.

Heating Houses. — The body can regulate its heat so that a person can live in air which is either colder than freezing, or warmer than the body itself. But it can regulate its heat most easily when the temperature of the air is about halfway between freezing and body heat. This temperature is from 65° F. to 70° F., and is the most healthful temperature for a living room in winter. If living rooms are heated warmer than 70° F., the air usually feels too warm, and if they are cooler than 65° F., the air usually feels chilly.

It would be easy to heat a house if the same air could be kept in it hour after hour. But if a room is properly ventilated on a cold day, the steady stream of outdoor air which flows into the building will have to be heated. Many persons do not ventilate their houses in winter because ventilation cools their rooms.

Yet the sickness caused by the foul air usually costs much more than the wood and coal which are saved by not ventilating the rooms.

Methods of Heating. — A fireplace is a healthful form of heater, for the draft of the chimney carries away a great deal of foul air from the room. But a fireplace wastes a great deal of the heat.

A stove supplies heat cheaply, for it gives its heat directly to the air of the room. But it does not ventilate the room, for it carries away very little of the foul air.

The hot-air furnace in the cellar is a popular form of heater. It sends the heat through the house by means of a stream of heated air. Furnaces which send the heat to the rooms by means of steam or hot water are economical, but they do not ventilate the rooms.

Stoves which burn oil or gas are sometimes used to heat rooms, but they are unhealthful, for most of them pour their burned gases into the air, and make it foul.

Moisture in Heated Air. — Air always contains some vapor of water. Air at a temperature of 70° F. can hold over three times as much vapor as air at a freezing temperature. Damp air which is freezing cold becomes very dry air when it is heated. The heat does not take away any of the vapor from the air, but it makes the air able to carry a great deal more vapor than cold air can carry.

In cold weather the heated air of houses is usually too dry, and takes water from every moist thing which

it touches. It takes moisture from the skin, nose, and throat, and makes them tender and unable to resist the growth of disease germs which may fall upon them. Dry, heated air is as harmful as a draft of cold air.

Dry, warm air also dries the perspiration from the skin rapidly, and makes the body feel cold. If the air is moist, it cannot take away the perspiration rapidly. Moist air at a temperature of 65° F. feels warmer than dry air at 70° F. You can save both heat and health by keeping a pan of hot water on the stove, or register, or radiator, or by keeping the water tank of the furnace filled, if a hot-air heater is used.

Lighting a Room. — Lights which are produced by burning use up oxygen and make the air foul, just as breathing does. A candle uses about as much of oxygen as a man. A bright light made by burning kerosene or gas uses about as much oxygen as five or ten men. Electric lights do not use up oxygen or make the air foul at all, for their light comes from white hot wires which lie inside of air-tight glass bulbs. Electric lights are usually the most healthful of all the means of lighting houses.

Coal Gas Poisoning. — A coal stove burning with a poor draft often gives off a gas, called carbon monoxide. This substance is very poisonous, for when it is breathed, it unites with the red blood cells, and prevents them from carrying oxygen through the body. This same substance is one of the principal things in illuminating gas. We can tell it by its smell. If there is the least

smell of carbon monoxide in a room, the air is dangerous for breathing.

Weather. — Some persons think that during bad weather, the outdoor air contains something which is likely to make them sick, and so they shut the air out of their houses on unpleasant days. Most of the diseases which these persons fear are caused by disease germs in the foul air of their houses and meeting places, and not by outdoor air at all. Weather and climate are due principally to four conditions of the outdoor air: 1, temperature; 2, motion, or the wind; 3, dampness, such as rain and fog; 4, sunshine. Nearly all the unhealthful effects of bad weather are caused by changes in the temperature of the body. If the weather is unpleasant, you can protect yourself with your clothes and houses.

Alcohol and Body Heat. — Alcohol is easily oxidized in the body, and produces a large quantity of heat soon after a person takes it (p. 132). But the body tries to get rid of the extra amount of heat by causing the arteries of the skin to expand (p. 103). The large quantity of blood which flows through the skin gives a feeling of warmth, but the heat is on the surface, and soon passes off. Alcohol cools the body instead of warming it. Those who travel in arctic lands find that, when they do not use alcohol, they can endure cold much better than when they use it.

QUESTIONS

- What produces the heat of the body?
- What is a *thermometer*?
- What is the natural temperature of the body?
- What is a *fever*?
- What is the usual cause of fever?
- What is the cause of the chilly feeling which is often present at the beginning of a fever?
- In what two principal ways does heat pass off from the body?
- How does the blood flowing through the skin help to regulate the temperature of the body?
- How does the perspiration help to regulate the temperature of the body?
- What is a sunstroke? What may be done to help a person who has a sunstroke?
- How do clothes keep the body warm?
- How may cotton cloth be made as warm as woolen?
- Why do wet clothes feel cool?
- In what way does cold, damp weather help people to take cold?
- How may a draft of cold air help to cause a cold?
- What is the most comfortable temperature for a living room?
- Why is a fireplace a healthful form of heater?
- Why is the air of a heated room usually drier than the air out of doors?
- Why is dry air in a heated room harmful?
- Why are electric lights a more healthful form of lighting a room than lights produced by burning kerosene or gas?
- What is the danger from breathing coal gas?
- In what way do changes in the weather harm the body?
- What effect does alcohol have on the temperature of the body?

CHAPTER XVI

THE SKIN

Structure of the Skin. — The skin consists of a thick network of connective tissue fibers, called the *dermis*, or true skin, which is covered with a thin sheet of epithelial cells, called the *epidermis* (p. 24). When the dermis of an animal's skin is hardened by tanning, it forms leather. The connective tissue in the dermis of a person's skin looks like the fibers of fine leather.



A sweat gland.
Magnified.

The color of the skin is due partly to the red color of the blood in the skin, and partly to a thin layer of colored cells in the deep part of the epidermis. These cells become colored brown, or *tanned*, when a person is exposed to the sunshine a great deal. Their use is to act as a curtain and protect the skin from being burned by the rays of the sun.

The Epidermis. — The epidermis consists of several layers of flat epithelial cells, which are like soft scales (p. 22). The cells are formed next to the dermis, and as they grow, they are pushed away by other cells which grow beneath them. The older cells become dry and loosened, and are finally worn away. The whole epidermis is shed about once a month. If the cells were not worn away from the surface, the epidermis would become an inch or more in thickness.

The epidermis contains no blood tubes or nerves, and so it may be cut or pricked without pain. It is strong enough to protect the blood tubes and nerves of the dermis from injury, and yet it is so thin that it does not interfere with cooling the blood, or with the feeling of touch.

The epidermis is waterproof, and prevents liquids and other substances from passing into the true skin. For this reason a person can handle poisons and disease germs without danger. When medicines are given with a hypodermic syringe, a hollow needle is thrust through the epidermis and the drug is forced through it into the flesh.

The waterproof epidermis also prevents lymph from escaping from among the cells of the flesh (p. 99). As a wound upon the skin heals, new cells of epidermis grow over the spot. When the epidermis is loosened from the dermis, as by scalding or hard rubbing, the lymph collects under the loosened part, and forms a bag of liquid, called a *blister*.

Finger Prints. — The surface of the dermis is covered with pointed projections, called *papillæ*, in which nerves of feeling end. The *papillæ* on the balls of the fingers and palms of the hands form ridges and lines which appear as spiral patterns upon the surface of the skin.



Finger prints.

Press the ball of your forefinger upon an inking pad, such as is used for rubber stamps, and then make a print of the finger upon white paper. An exact print of the ridges will be left upon the paper.

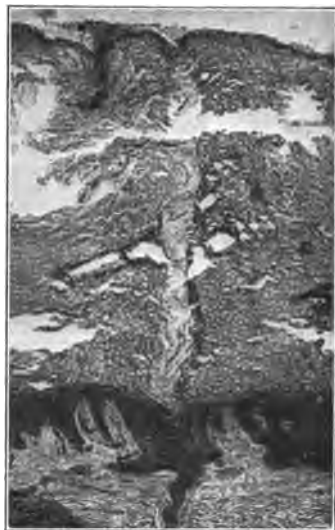
The pattern of the lines on a person's finger remains the same through life, and is different from the patterns on all other persons. A person may be distinguished by his finger print more surely than by any other means. The finger prints of prisoners are taken and preserved in order that the criminals may be known if they should be arrested again.

Perspiration. — If the skin is touched to a clean piece of cold glass, vapor of water will pass off from it and will form a spot upon the glass. This water is the perspiration, or sweat. It is formed in deep glands, and is discharged from the skin through openings which are sometimes called *pores* (p. 24).

The principal effect of perspiration is to cool the body (p. 154). It also helps to carry away waste

matters. About a pint of perspiration is formed each day whether the weather is warm or cold, but on a hot day over a gallon may be formed if hard exercise is taken.

The Complexion. — Harmful waste matters in the blood often cause the skin to have a rough and muddy look. Powders and paints may cover up the skin, but they do not make it fair. The only way to get a beautiful complexion is to live in such a way that the waste matters of the body will be of a harmless kind, and such as may easily be thrown off from the body.



Outlet of a sweat gland extending through the epidermis.

Dirt on the Skin. — When perspiration dries from the body, the substances which are dissolved in it are left as dirt on the skin. Other dirt on the skin consists of dead scales of epidermis, and of dust and bacteria from the air. Bacteria of decay often grow in the dirt and in the mouths of the sweat glands, and give the skin a bad odor. The disease germs which cause wounds to become red and sore often grow on a dirty skin, and enter the body when the skin is wounded.

Disease Germs on the Skin. — The dirt and dust which are on the skin often contain disease germs which would cause sickness if they should enter the mouth. Many persons catch typhoid fever, diphtheria, or other diseases by touching their mouths or food with hands which are soiled with dirt containing the germs of the disease. A dirty skin is unpleasant, and is also dangerous to health, for dirt and an odor on the skin are signs that disease germs also are there.

Cleanliness. — The reason for cleansing the skin is to get rid of three things: first, dirt, which looks bad; second, an odor, which smells bad; and third, disease germs. These three things usually go together. A skin that is clean and has no odor is almost free from disease germs.

Bathing. — The loosened shreds of epidermis which naturally peel from the skin carry a great deal of dirt with them. Rubbing the skin with the hands, or with a dry towel, will remove much of the loose epidermis, and will help to cleanse the skin. But the only way to keep the skin clean and free from odor and disease germs is to bathe the whole body with water.

Your skin will have an odor of dirt and perspiration unless you take a warm bath with soap and water at least once a week. A bathroom is one of the most important and useful of all the rooms in a house, for it makes bathing easy and pleasant.

Many cities support public baths. In many large factories there are bathrooms and warm water, for the

owners find that bathing improves the comfort and health of the workmen, and enables them to do better work.

Bathing for Refreshment. — A hot bath will cause the arteries of the skin to become large. When a large quantity of blood flows through the skin, the amount which flows through the head and the organs within the body will be lessened. A hot bath is useful in making a person feel quiet and restful after he has been studying or thinking hard, for it causes the blood to flow away from the head. The best time to take it is at night just before bedtime.

Cold Baths. — A cold bath will cause the arteries to contract, and will force the blood away from the skin and into the head and internal organs. Thus it will rouse a person and make him feel active and ready for work. The best time to take a cold bath is in the morning on getting up. Athletes and other strong persons will be helped by a cold bath, but weak and sickly persons are likely to be harmed by a bath which chills their bodies.

Congestion and Hot Water. — When any part of the body contains too much blood, we say that it is *congested*. A draft of cold air blowing upon the neck, or arm, or leg may cause the arteries of the skin of that part to contract. The blood which is intended for the skin may then flow into the muscles under the cold skin, and may cause them to become congested and painful. Many of the pains which are called *rheumatic*

pains are due to the cooling of one part of the skin more than another.

Heating the skin over a painful part will often relieve the pain by causing the blood to flow into the skin. One of the best ways for applying the heat is to put a hot-water bag over the painful spot. Another way is to wrap it in a blanket or cloth wrung out of hot water.

Clean Clothing. — Clothing becomes soiled by substances which are rubbed from the skin. Underclothes which have been worn for a week will contain the same kinds of dirt and disease germs that were on the skin. Soiled clothing is dangerous to health.

Clothes which have been well washed and ironed are free from disease germs and dirt. The washing removes most of the germs, and those which remain are killed by the heat during the ironing. If the clothes are then handled with clean hands and are stored in a clean place, they will remain clean and healthful.

Hair. — Hairs are found on nearly every part of the body. They grow from roots deep in the skin, and are formed by the matting together of epithelial cells, like those of the epidermis. Medicine rubbed on the surface of the skin cannot reach the roots and make the hair grow.

Hair roots are set slanting in the skin, but they may be pulled upright by muscles. When the muscles contract, they pull the roots up and the skin down, thus producing the roughness of the skin called *goose flesh*.

This roughness may often be seen when the skin is cold.

Each hair root has a gland, called a *sebaceous* gland, which forms an oil. The oil keeps the hair and skin soft, and helps to make the skin waterproof.



Section of skin : *a*, hair root; *b*, muscle; *c*, oil gland; *d*, epidermis.

Care of the Hair. — The hair of the head catches a great deal of dust which may contain disease germs. The dirt may be rubbed upon a pillow during sleep, and the disease germs may then enter the nose and produce a disease. Combing and brushing the hair removes the dirt and disease germs and helps to keep a person healthy. The scalp and the hair need a bath in soap suds every week or two.

Washing the hair will help to prevent the scales called *dandruff*. These scales consist of bits of epidermis, and are often caused by disease germs which are spread from one person to another by combs and brushes. Use only your own comb and brush, and carry them with you when you go traveling.

Pimples. — If a hair root is unhealthy, disease germs may grow in it, or in its oil glands, and produce a small collection of pus, called a *pimple*, or *boil*. Every pimple and boil has a hair in the center from which it starts.

Pimples and boils will seldom form if a person is healthy and well. But if a great deal of waste matter is circulating in the blood, the cells of the epidermis



Cutting off a hangnail.

may be unable to prevent disease germs from entering the flesh. One of the best preventives of pimples is to eat, drink, and exercise properly, so that the waste substances of the body will be as slightly poisonous as possible (p. 33).

Nails. — The nails on the fingers and toes are composed of hardened cells of epidermis.

They are not poisonous, but the dirt which collects under them often contains dangerous kinds of disease germs, for it is composed of nearly every kind of dirt which is touched. Dirty finger nails are both untidy and dangerous. They have often been the cause of sickness by carrying disease germs to food, or into the nose and eyes, or into slight scratches on the skin. Keep your finger nails clean in order to prevent the spread of disease germs from them.

A hangnail is a sliver of epidermis which has been torn from the skin just behind the nail. Do not tear it off or bite it, but cut it off close to the skin with a sharp knife.

QUESTIONS

Of what is the dermis composed?

Of what is the epidermis composed?

To what is the color of the skin due?

Of what use to the skin is the coloring matter called tan?

What are some of the uses of the epidermis?

How is a blister formed?

What is a common cause of a poor complexion?

What is the *perspiration*?

What are the uses of the perspiration?

Of what does the dirt on the skin consist?

Where do disease germs on the skin come from?

Give some reasons for keeping the skin clean.

How often does the whole body need a bath?

What effect does a hot bath have on the body? When should it be taken?

What is *congestion*?

How does a hot-water bottle help congestion?

Give some reasons for washing clothes.

Describe a hair root.

What is the cause of goose flesh?

Give some reasons for keeping the hair clean.

How may dandruff be prevented?

What is the cause of pimples?

How may pimples be prevented?

In what way are dirty finger nails dangerous to health?

How may a hangnail be cured?

CHAPTER XVII

EXCRETION

The Waste Matters of the Body. — Life is supported by the water, minerals, protein, fat, sugar, and oxygen which are taken into the body. After the oxygen has united with the other substances, they all become waste matters which the body throws off. These useless substances are called *excretions*.

The principal excretions are carbon dioxide, urea, minerals, and water (p. 32). All these, except water, are somewhat poisonous, but small quantities of waste substances which are very much more poisonous are formed when the oxidation in the body is disturbed.

The principal organs of excretion are the lungs, the kidneys, the skin, and the intestine.

Excretion by the Lungs. — About a pound of carbon dioxide is produced in the body each day, and nearly all of it passes off through the lungs, but a little also passes off through the other organs of excretion. The lungs also give off about a pint of water each day in the form of vapor in the breath.

The Kidneys. — The greater part of the urea and waste minerals of the body are excreted by two organs, called the *kidneys*, which lie on opposite sides of the

backbone just behind the lowest ribs. Persons who have a backache often suppose that the pain is in the kidneys. This is hardly ever so, but the pain is nearly always in the muscles of the back.



A kidney cut in two.

The kidneys are glands whose tubes are composed of cells of epithelium (p. 24). The cells take waste matter and water from the blood, and produce a mixture, called the *urine*, which they send into a bag, called the *bladder*.

The Bladder. — The bladder lies in the lowest part of the trunk of the body. Its use is to receive urine from the kidneys, which produce it during every moment of the day and night. It is made of muscle and holds about half a pint. About three pints of urine are formed in each twenty-four hours, and so the bladder needs to be emptied at least six times a day.

Excretion by the Skin. — The glands of the skin give off a little urea and minerals, and a great deal of water (p. 24). The mixture of these substances is the perspiration or sweat. The minerals give it a salt taste.

The kidneys give off about ten times as much waste

matter as the skin, but when they are diseased, the work of the skin is of great importance in helping to get rid of the waste substances which the kidneys are then unable to throw off.

Excretion by the Intestine. — The intestine also excretes waste matter. Some of the waste matter consists of bile and other substances which are taken from the blood, and some is undigested food.

Drinking Water and Excretion. — Drinking a great deal of water helps the kidneys and skin to get rid of waste matters, for the water dissolves the urea and other substances, and washes them away from the body. Some of these waste substances do not dissolve readily in water, and so a great deal of water is required to wash them away. If enough water is not taken, the waste matters often harm the kidneys, and produce Bright's disease and other forms of kidney trouble.

The natural quantity of water which passes off from the lungs, skin, and kidneys each day is about six pints. About two pints of water are taken with food, and so a person needs to drink about four pints of liquid each day. This is about equal to two large cupfuls of water, or tea, or coffee, or milk, three times a day.

Alcohol and Excretion. — When alcohol is taken into the body, it uses oxygen which should go to the cells and the food (p. 132). The waste substances of the body are then only half oxidized, and are much

more harmful than the natural wastes. These poisonous wastes often produce diseases of the kidneys and skin. One of the most common causes of kidney diseases is alcohol.

Disease Germs in the Excretions. — When a person has an infectious disease, many of the disease germs pass off from the body with the excretions of the intestine and kidneys. They are also found in the mucus and phlegm of the nose and throat. Very few of the germs pass off from the skin unless it is diseased, but they may often be found on the skin when it is soiled by the excretions. The water in which the sick person has washed or bathed will usually contain disease germs.

Disposal of Excretions in the Country. — One of the easiest and safest ways of disposing of excretions in the country is to keep them dry by covering them with ashes or dry earth. If this is done, flies will not crawl over the excretions, and there will be no drainage from them into the underground water from which wells are supplied.

Disposal of Slops in the Country. — The waste water which has been used in bathing, laundering, and house cleaning often contains disease germs. When the slops are thrown upon the ground, they sink into the soil. The upper layer of the soil always contains bacteria which oxidizes and destroys the disease germs and other impurities. The soil also screens out the solid particles from the sewage, and allows only pure

water to soak into the deeper parts of the soil. Underground water is nearly always pure, unless a great deal of dirty water is poured upon the ground in one spot.

Many persons allow their slops to flow from their kitchen waste pipes upon one spot until the ground is soaking wet, and the useful bacteria of the soil are drowned from want of air. The slops and waste matters may then form a dirty pool from which disease germs may be carried away by flies and other vermin. If you have no other means for getting rid of slops, catch them in a pail, and when it is full, empty them in the back yard away from the well, first on one spot and then on another.

Sewage. — The waste water of a house or barn is called *sewage*. Nearly all sewage contains excretions from human beings. Sewage will contain disease germs when it contains excretions from a person who has an infectious disease. It often spreads diseases in two ways: first, by flowing into drinking water; and second, by being carried to food, or to the mouth and nose, by flies or by other means. The safe disposal of sewage is one of the most important matters with which the people of cities and towns have to deal.

Cesspools. — In houses with bathrooms, the sewage contains both excretions and slops. This mixture may not be emptied on the ground with safety. One way to dispose of it is to empty it into an underground tank, called a *cesspool*. There its solid parts slowly decay and become harmless, and the liquid soaks into

the soil. A cesspool which is properly constructed and which acts properly will destroy the disease germs which may be in the sewage.

If a cesspool receives more sewage than the soil is able to purify, the sewage will reach the underground water and make it unfit for use. The underground water in villages is seldom pure if cesspools are used.

Sewage from a cesspool may flow along an underground rock or a layer of water-tight clay, and reach a well or pump from which drinking water is taken. If a cesspool and a well must both be placed in the same yard, locate the well in a place from which both the ground and the underground rock slope away from it.

Another danger from a cesspool is that flies may carry disease germs away from it, or mosquitoes may breed in it. A cesspool is not safe unless it is covered so closely that flies and mosquitoes cannot enter it.

Sewers. — Cities and large villages make more sewage than cesspools can safely receive. In these places the sewage is taken away by means of underground pipes, called *sewers*, which are built at public expense. The sewage from a small city would make a good-sized stream, and that from a large city, like New York, would make a river. It is difficult to get rid of this great quantity of sewage. Many cities, such as New York, Albany, and Troy, empty their sewage into the nearest body of water. But the sewage makes the water impure, and spoils it for the people of

other cities who wish to use the river water for drinking or washing. The people of the city of Albany take their drinking water from the Hudson River, and have been put to great expense in removing the sewage which is poured into the river by the people of the city of Troy.

Sewage Disposal Plant. — One of the most necessary public works for a city or large village is a sewage dis-



Filter beds in a sewage disposal plant.

posal plant which purifies the sewage. A sewage disposal plant which acts properly will destroy all disease germs which may be in the sewage.

One of the best forms of sewage disposal is to collect all the sewage into a large water-tight cesspool, called a *septic tank*, where its solid parts decay and become

liquefied as in a small cesspool. The liquid which overflows from the tank is emptied on plots of sand, first on one, and then on another, so that each plot is used only once a day. The soil destroys the impurities in the sewage, just as the soil does when a basin of slops is thrown on the ground in a back yard. This method of getting rid of sewage is almost like nature's own way of purifying dirty water. A sewage disposal



Sewage flowing over broken stone.

plant that is run properly is no more unpleasant to sight or smell than a stable or barn yard.

In some sewage disposal plants the impure water which flows from a septic tank is sprayed upon large beds of broken stone before it flows upon the soil. The stone bed removes the greater part of the impurities and only a small area of soil is needed to complete the purification.

Gas Trap. — The pipes which carry waste water away from houses are laid sloping so that the water will quickly run out of them. The waste pipes are

nearly always empty, and are likely to let foul-smelling gases into the room, unless they have arrangements, called *traps*, to keep the gases out.

In a common form of trap, the upright part of the waste pipe under a tub or basin is bent in the form of a deep loop. When the tub or basin is emptied, the loop of the pipe remains full of water, and prevents gases from escaping.



A gas trap under a sink.

The plumbing of a house will be unsafe unless there is a trap in each waste pipe under the sinks, bathtubs, and basins.

Garbage. — The solid waste matter from a kitchen is called *garbage*. It consists of such things as scraps of food, potato peelings, meat rinds, bones, dirty tin cans, and ashes. These are often thrown in a pile behind an outbuilding. Slops are often thrown over them, making a foul mass in which disease germs live. House flies often flit back and forth between the pile and the kitchen, and carry filth and disease germs to food. A garbage heap is dangerous to health.

You can easily get rid of garbage without throwing it into heaps. Feed scraps of food to chickens or pigs; or burn them. Burn or bury everything else that will decay.



A garbage heap is a breeding place of diseases.

In many cities, the garbage is collected at public expense, and sorted. Much of it is put to use so as to help pay the cost of its disposal. For example, grease and fat are preserved for soap making, and wood and paper are burned under steam boilers.

QUESTIONS

What is an *excretion*?

Name the principal excretions of the body.

What are the principal organs of excretions?

What substances are excreted by the lungs?

What substances are excreted by the kidneys?

What substances does the skin excrete?

What substances are excreted by the intestine?

How does drinking plenty of water help the kidneys and skin to excrete waste matters?

How much water does a person need to drink each day?

What effect does alcohol have on the excretions of the body?

How do the excretions of the body help to spread diseases?

What is *sewage*?

How does the soil destroy disease germs when sewage is thrown upon it?

Describe a good way to get rid of the waste water from a kitchen sink.

What is a *cesspool*?

What becomes of the excretions which are run into a cesspool?

What are the dangers from a cesspool?

What is a *sewer*?

Describe a *sewage disposal plant*.

What is a *septic tank*?

What is a *gas trap*?

What are some of the dangers which arise from a garbage heap?

How can you dispose of garbage safely?

CHAPTER XVIII

WATER SUPPLY

Quantity of Water Needed Daily. — Each grown person needs about three quarts of water to replace that which passes off from the body each day. One or two gallons of water will be needed for preparing and cooking his food, and for washing dishes; and at least another gallon will be required in washing and bathing the body. Each person requires at least three gallons, or one large pailful, of water each day.

In many families each person uses at least five gallons a day in bathing, laundering, and house cleaning. If the house has a bathroom, this quantity will be much more than doubled. A great deal of water is also used in stables and in the care of animals. A city has to supply at least thirty gallons a day for each person. London supplies thirty-five gallons a day for each inhabitant. New York supplies one hundred and thirty gallons, but much of it is wasted.

Source of Water Supplies. — The simplest way to get a supply of water is to take it from a natural spring, or stream, or lake. Another way is to dig a well, or drive a pump, so as to reach the underground water. Another way is to catch rain water from a roof and store it in a cistern.

Those who live in cities and large towns draw water from pipes which connect with the public waterworks, but the water usually comes from streams or lakes.

There are differences in the taste and appearance of water from various places. The differences are due to substances which are contained in the water.

What is in Water. — Water always has substances dissolved in it. The purest water is rain water, but that has air in it. If we could get water with nothing dissolved in it, we would not like it, for the pleasant taste of good water comes from the air which is dissolved in it.

Boil some water in a clean kettle for five minutes. It will now taste flat and unpleasant, for most of its air has passed off with the steam. Now stir or shake it to a foam so that it will become mixed with air. It will now taste like fresh water again.

Underground water, and the water in springs, streams, and lakes, comes from rain or snow. As the water soaks through the ground, it dissolves lime, salt, and other minerals from the soil. Nearly all underground water has a little lime and salt dissolved in it.

Let a drop of clear water dry on a clean glass. It will leave a whitish spot of minerals which had been dissolved in the water. You can often see these spots of minerals on a window after it has been washed.

Soft and Hard Water. — The minerals in water are often too small in quantity to be noticed. Such water is called *soft* water.

In some places the water has so much lime dissolved in it that the minerals form a scum when soap is added to the water. Such water is called *hard* water. The minerals in hard water do not make it unfit for drinking. Hard water is sometimes not good for cooking, for some foods, such as peas and beans, do not easily become soft when they are boiled in it.

Mineral Water. — If water has a great deal of mineral substances dissolved in it, we call it a *mineral* water. Some mineral waters are bubbling full of carbon dioxide which gives them a pleasant taste and a sparkling appearance. Some waters contain sulphur, or iron, or potash, or other minerals which are used as medicines. The good effects of drinking mineral water come from the water itself as much as from the minerals which are dissolved in it, for many persons who usually drink too little water will drink large quantities of mineral water.

Impurities in Water. — Most of the water which is used in houses contains either pieces of wood and leaves, or bits of iron rust, or particles of clay and mud. A little of them will do no harm, but if the water is muddy, or colored, or tastes bad, it will be likely to harm those who drink it.

Almost the only dangerous impurities in water are disease germs. The principal reason why dirty water is harmful is because disease germs are often found in the dirt. But disease germs may be in water which is clear and sparkling, and is pleasant to the taste.

How Disease Germs get into Water. — Dirty water will not produce a disease unless it contains living germs of the disease. Disease germs are not produced by dead leaves, or grass, or sticks, or mud. They are formed only in the bodies of sick persons or animals. If they are in water, it is because they came there with the excretions and sewage from a sick person, or a sick animal. Keeping water pure means keeping it free from sewage and from dirty water from houses and barnyards. Nearly all the dangerous impurities in water come from human beings.

Diseases caused by Impure Water. — The principal kinds of disease germs which are found in impure water are those which cause stomach aches, typhoid fever, and other diseases of the intestine. Most rivers which flow past farms or towns contain sewage, and many of the people who drink the water of the rivers are made sick, unless the water is purified before it is used. Hundreds of people die each year in the United States from typhoid fever which is caught from drinking water containing sewage. Nearly all of these deaths are due to carelessness and neglect, and could easily be prevented by taking proper care of sewage. In one small city over a thousand persons caught typhoid fever because the slops from a person sick with typhoid fever were thrown upon a frozen hillside, and later were washed into the river which supplied the city with drinking water.

Pure Drinking Water in the Country. — People in

the country usually get their drinking water from wells which are sunk into the underground water. This water is nearly always pure, unless some ignorant or careless person allows excretions, or slops, or barnyard drainage to run into the well, or into the underground water which feeds it.

Many wells are unfit for use because they are placed over underground streams of dirty water flowing from



An unsafe well.

cesspools, or wet barnyards, or from dumping places for slops and excretions. The place for a well is on the highest part of a yard, so that all dirty water, both from the surface and from underground, will flow away from it.

If a spring or well is open at the top, or has sides of

brick or stone, dirty surface water, worms, and other impurities may fall into it, or may drop through cracks in the bricks or stones. An old-fashioned open well is not safe, even if the underground water is pure when it flows into the well. A well made by driving a small iron pipe into the ground is safe if the underground water is pure, for no dirt can fall down it.

Pure Drinking Water in Cities. — The people of cities have their water brought to their houses through aqueducts and pipes which are fed from public waterworks. If the water in the works is pure, the water in the houses will also be pure, for nothing can get into the pipes except that which comes from the waterworks.



A driven pump.

Many cities take their water from rivers or lakes which contain sewage. If they do not purify their water, they have more typhoid fever than those which do purify it, or which take their water from pure sources. In the city of Albany, during the ten years following the year 1900, there was only one fourth as much typhoid fever as there was during the ten years before 1900, because since 1900 the



Aqueduct which brings water from the Catskill Mountains to New York.

in purifying drinking water, but it alone will not make impure water entirely safe.

public water has been purified before being sent through the city.

Reservoirs.—

One way of purifying drinking water is to store it in a reservoir for a few days. The dirt and mud, and most of the bacteria, will sink to the bottom, and the sunlight will kill many of the bacteria. A reservoir is a great help



Water filtration plant of Albany, N. Y.



Interior of a filter tank in the Albany filtration plant.

Filtration. — One of the easiest and best ways of purifying water is to pass it through a large bed of sand, called a *filter*, which strains out dirt and bacteria. The soil is a great filter (p. 176). If a filter is very large, and the water passes through it slowly, it will take out very nearly all the dirt and disease germs that may be in the water. Albany, Philadelphia, and many other large cities which have to take their water from impure



Water gates in the Albany filtration plant.

ivers, pass the water through great filters, and by doing so they protect thousands of persons from sickness, and hundreds from death each year.

If a filter is small, or if water is run rapidly through it, the flow of water will wash bacteria and disease germs through it as if it were a sieve. For this reason the small filters sold for use in kitchens will not purify the water.

Purifying Water by Boiling. — If drinking water is not pure, we can make it safe for use by boiling it, for a boiling heat will kill the disease germs. Many persons who fear to drink plain water drink tea or coffee. The tea or coffee which is added to the water does not make the water safe, but the heat of boiling the drink kills the disease germs in the water. The Chinese are able to drink dirty river water with safety, because they boil the water which they drink, and cook all their food before eating it.

Water which has been boiled for some minutes tastes bad, because the boiling drives the air from it (p. 185). If the water is taken from the fire as soon as it begins to boil, the disease germs which may be in it will be killed, but the water will not lose its air, and its taste will not be changed.

Ice. — Ice taken from impure water will contain disease germs if the water contained germs before it froze. Those who work or skate on the ice may leave disease germs on it, or the ice may be soiled by the dirty hands or dirty clothes of those who handle it.

Cold will not kill the germs, but they will grow as soon as the ice melts. The purity of the ice which is put into food and water is of as much importance as the purity of the food and the water themselves.

Washing with Impure Water. — Impure water which is used in bathing the body or in washing dishes may be the cause of spreading diseases. Milk cans which have been washed in impure water have often been the cause of typhoid fever in those who have taken milk from the cans. It is almost as dangerous to use impure water for washing as for drinking.

Examining Water. — We cannot always tell whether or not water is fit to drink by looking at it, or smelling it, or tasting it, but we may be sure that water is not fit for use if it is colored, or cloudy, or has an unpleasant taste or smell.

We can tell a great deal about the purity of water by examining the country around the well or stream from which it comes. If any drainage from houses, or barnyards, or cesspools is found near it, the water is likely to be unsafe for drinking.

Water which looks, smells, and tastes good may still contain disease germs. If the germs are present, they may be found by a trained chemist or doctor. The boards of health of many of the states and large cities will examine public water supplies free of charge.

Public Drinking Cups. — Drinking cups are often placed in schools, in railroad trains and stations, and in public buildings, to be used by any one who wants a

drink. Every person who takes the cup between his lips leaves mucus, and epithelial cells, and bacteria



Paper drinking cups.

from the mouth upon the rim of the cup, and the next person who drinks from the cup takes some of them into his mouth, and leaves more from his own mouth upon the cup. Some one who has a cold, or a sore throat, or a worse disease, is almost sure to use the cup and to leave disease germs upon it. Tuberculosis and diphtheria are two diseases which are likely to be spread by the use of the cups. Public drinking cups are so dangerous that some states have laws that none shall be placed in any public place in those states.



A safe drinking fountain.

Paper drinking cups are often placed in public drinking fountains, and are for sale at drug stores and stationers. They are to be

thrown away as soon as they have been used. They are cheap and may easily be carried. Take some with you and use them when you go away from home, or when you start on a journey.

A safe form of public drinking place is one in which the water bubbles up in a stream about as large as your finger, and about an inch high. You drink by placing your lips to the running stream. In drinking in this way you run no danger of taking anything which another person has left at the fountain.

If you must use a public drinking cup, do not take the rim between your lips, but touch both lips to the water inside the rim. In this way your lips will touch nothing except the water of the cup.

QUESTIONS

How much water does a man need to take into his body each day?

About how much water will each person in a family use in a day?

What substances are always found in water?

Of what use is air in water?

What is meant by hard water?

What are mineral waters?

Of what do the common impurities in water consist?

What are the most dangerous impurities in water?

How do disease germs get into water?

What diseases are often caused by impure water?

Why is water from an open well not so safe as water taken from a driven pump?

How does storing water in a reservoir help to purify it ?

What is a *filter* ?

How does boiling purify impure water ?

How may ice be a means of spreading diseases ?

How can you tell whether or not a water supply is pure ?

What harm is often done by the use of public drinking cups ?

Describe a safe form of drinking fountain for schools.

How can you drink from a public cup with the least danger ?

CHAPTER XIX

VERMIN

How Insects cause Diseases. — Men used to think that flies, mosquitoes, and other insects did not harm a person's health, except by causing a tickling and itching when they bit the skin. It is now known that many of them are disease carriers, and are dangerous to health and life. Nearly all insects that bite the body may carry diseases from a sick person or animal to the next person or animal whom they bite. The most common and most dangerous insects that affect the health are flies, mosquitoes, cockroaches, lice, bed-bugs, and fleas.

Cats and dogs may also carry diseases to man. Insects and other small animals which are troublesome to man, or are harmful to health, are called *vermin*.

Bee Stings. — The stings of bees and wasps cause swellings which are painful for a short time, but they are not the cause of any disease, for none of the insects go from person to person as flies and mosquitoes do. Most insects which are harmful bite in order to get food, but bees and wasps sting only to protect themselves from harm. If one buzzes around your head, it will not touch you if you keep still and do not annoy it.

A bee stings by means of a hollow spear which it thrusts into the skin from the hinder part of its body. The spear itself is too small to hurt, but the bee uses it to force a bit of poison into the skin. This poison is what causes the swelling and the pain of the sting. You can relieve the pain somewhat by pinching the skin so as to squeeze the poison out of the flesh. Cold water, or a little ammonia rubbed on the spot will also help to relieve the pain.

Danger from House Flies.—A house fly cannot bite, or sting, or scratch, and yet it is dangerous



House flies and bluebottle flies.

because of the places which it visits in search of food. It lights upon garbage heaps and excretions, and in dirty stables, where its legs and body become soiled with filth and disease germs. It then flits into houses

and crawls upon food and over the mouths and eyes of helpless babies, dropping disease germs wherever it goes. The blue flies, which may often be seen swarming over decaying meat, may also be the carriers of disease germs.

A fly's body and legs are covered with stiff hairs, which catch dirt and filth. Under a microscope the fly looks like a bristly pig that has been wallowing in the dirt. It tries to keep itself clean, for it often rubs its feet together, and brushes its front legs over its head, as a cat does. It is usually covered with bacteria which it gets from the dirty places where it alights. Shaking a fly in a bottle of water will often wash more than a million bacteria from its body. A fly which falls into a milk pitcher usually leaves thousands of bacteria and disease germs in the milk.



House fly. *Magnified.*

The most common forms of sickness that are spread by house flies are typhoid fever and other intestinal diseases. Many of the stomach diseases of babies are caused by disease germs which flies have left in the children's milk or in their mouths. Sore eyes are often caused by flies crawling over a baby's face. Consumption is often spread by flies.

Protection against Flies. — A house fly will not carry disease germs if it cannot go where it can pick

them up. Keep flies out of all sick rooms. Cover all excretions and sewage fly-tight. Clean up the garbage heaps in the back



Maggots on a heap of fertilizer.

yard, and either burn or bury all decaying matter. If everybody did these things, flies would not carry diseases, for they could not get the germs on their bodies.

Another method of protection against flies is to cover windows and doors with screens and fly netting in order to keep all flies out of the house and away

from food. A swarm of flies in a kitchen or dining room is far more dangerous than a swarm of bees. In the Spanish war the number of soldiers who were killed by house flies was five times the number of those killed by bullets, for the flies spread typhoid fever through the camps.

The Life of a Fly. — A fly lives only half of its life as a winged creature. During the first half of its life it looks like a worm, and is called a *maggot*. Every maggot in a manure pile, or garbage heap, or mass of decaying filth, is a young fly.

Maggots hatch from eggs which are laid by winged flies in stable cleanings, wet garbage, decaying meat,

and wet filth of all kinds. The maggots reach their growth in about a week. Their skins then harden into brown shells, called *pupa* cases, which look like fat grains of wheat. The young flies lie quietly in the



Life history of a house fly.

cases for a few days and then come out as full-grown flies with wings.

Getting rid of Flies. — If there were no manure piles, or garbage heaps, or other masses of decaying filth, there would be no places in which flies could hatch or grow, and soon there would be no flies left alive. Remove all manure piles and garbage heaps at least once every week. Keep all stables and barnyards clean and dry. Doing these things throughout a town will rid the place of flies.

The time to begin to fight flies is early in the spring. Only a few flies live through the winter, and all that are seen in the following summer are descended from them. Each fly lays over a hundred eggs, and the new

brood is ready to lay eggs within two or three weeks. Every maggot or fly that is killed in the spring and early summer means thousands less flies later in the season.

Cattle Flies. — Many of the flies which bite horses and cattle look almost like house flies. They often come into houses and bite persons, and are sometimes the carriers of diseases. The disease called the spinal paralysis of children may be spread by the bite of stable flies which have bitten another person that has the disease. Stable flies often spread diseases among horses and cattle in Africa. Stable flies are born and bred in decaying filth and dirty barnyards, just as house flies are. We may get rid of them by doing the same things that prevent house flies from rearing their young.



Mosquito eggs and wigglers.

Mosquitoes

and Diseases. —

Certain kinds of mosquitoes are the means of spreading malaria and yellow fever, and for this reason they have been the cause of some of the worst epidemics that the

world has ever seen. The discovery that mosquitoes will carry diseases was made about the year 1900.

Before that time a great difficulty in living in Panama and Havana was to avoid catching malaria and yellow fever. These diseases have almost disappeared from those places since the time that the United States government has required the inhabitants to destroy all mosquitoes.

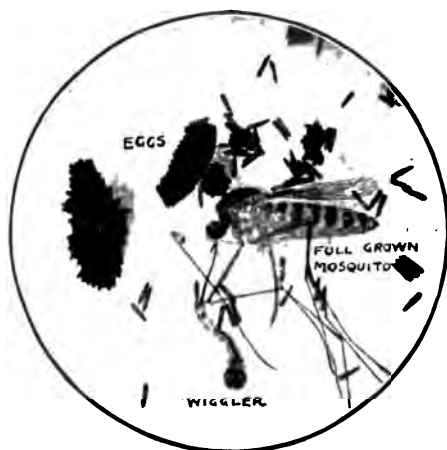
Malaria is caused by living germs which grow in the blood. A mosquito that sucks blood from some one who has malaria takes the germs into its body, and afterward gives them to persons whom it bites. The germs of malaria will live in only a few kinds of mosquitoes, but these kinds are scattered over a large part of the earth, and may grow wherever other kinds grow.

One way of telling a malarial mosquito is by its position when it alights, for it seems to stand on its head with the hinder part of its body pointing away from the surface on which it stands. It has spots on its wings.

Yellow fever is caught in the same way that malaria is caught, but the mosquito which carries the germs of yellow fever usually grows only in warm countries, for freezing kills it.

Life History of a Mosquito. — Mosquitoes hatch from eggs which are laid by the full-grown insects in any bit of quiet water that they can find. The eggs are black, and look like flakes of soot floating on the water.

Young mosquitoes are the tiny creatures, called *wigglers*, that may often be seen in rain barrels resting at the surface of the water, and wiggling themselves



Mosquito eggs, wigglers, and full-grown mosquito. *Magnified.*

away when they are disturbed. They are found in all kinds of stagnant water, such as marshes and mud puddles, and pails and cans of dirty water. Cess-pools are often full of them, and even vases of flowers may contain them.

About two weeks after they hatch, the wigglers change to winged mosquitoes which fly away, leaving their empty skins floating on the water.

How to get rid of Mosquitoes. — We can get rid of mosquitoes by destroying them in their breeding places. If mosquitoes can find no stagnant water in which to lay their eggs, no young ones can grow. Very many of the mosquitoes around houses are hatched in pails, tin cans, and rain bar-



A small ditch where mosquitoes breed.

rels. If these vessels of water are emptied once a week, young mosquitoes will not have time to become full grown in them.

Wigglers must come to the surface of the water to breathe. If kerosene or other oil is poured on the water, the wigglers cannot get air, and they soon drown. A teaspoonful of kerosene poured into a barrel



Wigglers in the ditch.

of rain water will kill all the wigglers in it, and will not harm the water for washing purposes.

The principal breeding places for mosquitoes are swamps and marshes that are full of stagnant pools. We may dry up the pools by digging ditches which will drain off the water and leave the surface dry. No mosquitoes can then grow except in the ditches, and there they will be eaten by fish, or carried away by the current of water. Many of the marshes near New York city have been freed from mosquitoes by being drained.

Cockroaches. — Cockroaches are long, brownish insects that live in cracks of kitchen floors, and among the water pipes, and in dark, damp places in houses. They do not bite persons, but they live upon garbage and filth, and may be the means of carrying disease germs to food as they crawl over it. They may be killed by means of insect powder. If floors of kitchens and bathrooms are tight, and the plumbing of the house is open and clean, the insects cannot find hiding places, but may be easily killed.

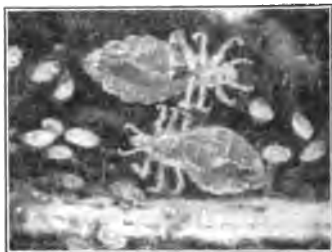
Lice. — A few kinds of insects may make their home on a person's body, and live by sucking his blood. The most common kind of insect on the body is a louse that lives among the hairs of the head. These lice are spread from one person to another by means of hats and clothes. They cause a tickling and itching by their crawling and biting, and may cause a person great annoyance. Sometimes a person may make his skin sore by scratching the itching spot.

Lice hatch from white eggs which are about the size of grains of sand. They are called *nits*, and are fastened to the hairs close to the skin. If the eggs are found at a distance from the skin, they have been laid for so long a time that the growth of the hair has carried them away from the skin.

Washing the hair in strong soap suds, to every pint of which a tablespoonful of kerosene has been added, will kill the lice, but the eggs may remain alive and hatch a new brood. After using the kerosene, soak

the hair in weak vinegar in order to dissolve the glue which binds the eggs to the hair. The eggs may then be washed away, and the head entirely freed from the lice.

Another kind of louse lives on the trunk of the body. These lice lay their eggs on the underclothes. Cleanliness and boiling the clothes will rid the body of the lice.



Body lice and eggs. *Magnified.*

Bedbugs. — Bedbugs are brown, flat insects about an eighth of an inch in length. They live by sucking a person's blood, and may carry a disease from one person to another. One disease which they may carry is typhus fever. In the daytime bedbugs usually crawl into cracks in bedsteads, walls, and floors. They can live for months without food. They have no wings and can crawl but slowly, and will not be found in a house unless some one brings them there. We may keep ourselves and our houses clear of them by keeping our clothes and rooms clean.

Fleas. — Fleas are small, brown insects that move by long jumps. They are often found on dogs, cats, rats, and other lower animals. They sometimes jump upon the bodies of persons. They live by sucking blood, and may carry disease germs from one person or animal to another.

The plague is a disease of rats as well as of mankind.

It is usually spread by means of the bites of fleas which have taken the germs from diseased rats. This disease killed millions of people in Europe a few hundred years ago, and is still found in uncivilized parts of the world. The two principal means of preventing the spread of the disease in a town is by killing all the rats in the place, and by keeping dwelling houses so clean that fleas will not live in them.

Rats and Mice. — Rats may become sick with several diseases which persons may take from them. Besides the plague, they may also have leprosy and tapeworm, and may spread the diseases to man. Both rats and mice may also carry disease germs in dirt on their bodies, and may spread them to food and drinking water.

The best way to get rid of rats and mice is to remove garbage heaps and loose grain on which they feed, and to clean up dirty cellars and piles of old boards and hay in which they hide out of the way of danger.

Stray Cats and Dogs. — When we say that a dog or cat is mad, we mean that it has the disease called *rabies*, or *hydrophobia*. Rabies is caused by germs which grow in the brains, and are also found in the mouths of the sick animals. Most of the animals and persons that have rabies catch it from the bites of homeless dogs and cats on the streets. A public dog-catcher, to catch all stray dogs and cats, is an important and useful officer.

The bite of a dog or cat is no more dangerous than

the prick of a splinter of wood, unless the animal has rabies. If a person is bitten by a dog or cat, do not kill the animal, but shut it up to see if it has rabies. If it has the disease, it will die within a few days. If it lives, it has never had rabies, and there is no danger that its bite will give any one rabies.

A person bitten by a rabid animal can escape having the disease by taking the kind of vaccination which is called the Pasteur treatment. You can get information about the treatment from the boards of health of the states and large cities.

Sick Pets. — Pet animals sometimes have the same kinds of sickness that people have, and persons may catch the diseases by handling them. Many persons have caught diphtheria by handling cats which had the disease. If your cat, or dog, or other pet animal is sick, do not handle it or leave it in the house, but give it a good bed in the woodhouse or barn, and let a careful grown person take care of it.

QUESTIONS

What are *vermin*?

Name some of the common vermin.

What harm do bee stings do?

How do house flies spread diseases?

What diseases are often spread by flies?

Where do flies get the disease germs which they carry on their bodies?

How may disease germs be kept from the bodies of flies?

How can we protect ourselves against flies?

Where are young flies found?

What is a *maggot*?

How may maggots be prevented from growing to winged flies?

What disease may be caught from the bite of a stable fly?

How may stable flies be destroyed?

What harm is done by mosquitoes?

How can you tell the kind of mosquito which produces malaria?

What is the cause of yellow fever?

How may malaria and yellow fever be prevented?

Where do young mosquitoes live?

How can we get rid of mosquitoes?

What harm is done by cockroaches?

How can we get rid of cockroaches?

What are *lice*?

What are *nits*?

How may lice and nits be removed from the hair?

What harm do bedbugs do?

What harm is done by fleas?

How do fleas help to spread the plague?

What have rats to do with the spread of the plague?

How can we get rid of rats and mice?

What disease is often spread by stray dogs and cats?

If a person is bitten by a cat or dog, what should be done with the animal?

If a person is bitten by an animal that has hydrophobia, what should be done to prevent him from taking the disease?

What harm might a sick pet do to your health?

CHAPTER XX

FOOD ELEMENTS

Definition of Food. — Food has two uses; first, to become new flesh, and second, to be oxidized and supply the body with heat and power.

Any substance which may become a part of living flesh, or may be safely oxidized in the body, is a food.

Foods are mixtures of protein, fat, sugar, water, and minerals. These are the same kinds of substances that compose the flesh and bones of the body (p. 28).

Starch is a food substance which is nearly like sugar, and which is changed to sugar after it has been eaten. We may count the starch in food as sugar. Starch and sugar are often called *carbohydrates*.

Flesh-forming Food. — The living cells of flesh are composed principally of protein (p. 29). The body does not make its protein out of other substances, but it takes bits of protein from food and adds them to the living flesh. A person doing light work needs about three ounces of protein each day in order to form new flesh in the place of that which becomes worn out. A food which contains a great deal of protein is called a *flesh-forming* food. Examples of this kind of food are lean meat, eggs, and beans.

Fuel Food. — Most of the heat and power of the body comes from the oxidation of the fat and sugar which are contained in food. When fat and sugar are eaten, they are quickly oxidized, and neither of them becomes living flesh. They are like the coal which is burned in a boiler, but which cannot become a part of the machinery.

Protein is like the iron of which the boiler and machinery are made. But protein is also a fuel food, for worn-out flesh is protein which has been oxidized (p. 173).

A food which contains a great deal of fat, or sugar, or starch, is called a *heat-producing* food, or a *fuel* food. Examples of this kind of food are fat meat, potatoes, and grain. But these foods contain some protein, and are also flesh-forming foods.

Water and Minerals. — Water and minerals are needed in order to carry on the oxidation and the rebuilding of the body, and yet they themselves do not become oxidized or changed. They go to every part of the body with the other food substances, and help the flesh to make use of the protein, fat, and sugar. Minerals are found in nearly all kinds of food, but a little salt is usually added to food on account of its taste.

Flavorings. — Pepper, vanilla, and other substances are often added to food in order to give it a pleasant taste. When food which has but little taste is eaten, the body cannot make the best use of it. The use of

flavorings is to help the body to make good use of its food.

Taste is also a great help in judging the purity and healthfulness of food. If food has a bad taste, it is usually not healthful.

Waste Substances in Food. — The body cannot make use of such things as bones, tough strings of flesh, the seeds and skins of fruit, and the husks of grain. All foods contain some of these waste substances, but they form the greater part of the solids of some foods, such as cabbage and turnips. Yet foods which contain a large amount of waste substances may be useful on account of their taste.

Alcohol as a Food. — Alcohol cannot become flesh. It may be oxidized in the body, and may give off heat, and therefore some persons would call it a food. The body is not made in such a way that it can oxidize alcohol with safety. Using alcohol as a food for the body is like using it as fuel in a coal stove. We cannot control the action of alcohol in the body any more than we can control its burning in a coal stove. Alcohol cannot be safely oxidized in the body, and it is not a true food.

Calorie. — We measure the food value of fat, sugar, or starch by the amount of heat which the food will produce when it is oxidized. We may also measure the food value of protein in the same way, for nearly all the protein which is built into living flesh takes the place of other protein which has been oxidized. A

growing child takes a little more protein than it oxidizes and in that way its body increases in size.

The quantity of heat in a mass of any substance is measured by what are called *calories*. One calorie is very nearly the quantity of heat which will warm two quarts of water one degree Fahrenheit. One hundred calories will change one quart of water from freezing cold nearly to a boiling heat. A man doing very light work produces about one hundred calories of heat each hour, or about twenty-four hundred calories in a day. He produces heat about as fast as two burning candles, such as are used in lighting houses.

If we know how many calories each kind of food will produce, we can reckon how much food a person needs to eat. If an ounce of protein, or an ounce of sugar, is oxidized, it will yield about one hundred and twenty calories. An ounce of fat will yield about two hundred and forty calories.

If a person should eat nothing but protein, his body would require about twenty ounces a day, or about as much as is contained in the whites of nine dozen eggs, in order to furnish the 2400 calories that he needs. If he should eat nothing but fat, about ten ounces of butter would supply the calories that he needs. If he should use only sugar for food, he would need about one and a quarter pounds each day. But he cannot live on either kind of food substance alone. A person needs to eat a mixture of protein, fat, and sugar in order to be healthy.

Amount of Food. — In reckoning what food to eat, first choose enough protein to replace that which is worn out and oxidized in the flesh. The amount of protein which will be needed is about three ounces a day (p. 211). This quantity of protein will produce three hundred and sixty calories of heat, which is about one sixth as much as the body needs. The remaining 2040 calories could be obtained from four ounces of fat and nine ounces of sugar, or from two ounces of fat and thirteen ounces of sugar. A person who does hard work will need much more than these amounts of food substances.

Protein,	3 ounces,	yielding	360 calories
Fat,	4 ounces,	yielding	960 calories
Sugar,	9 ounces,	yielding	1080 calories
			2400 calories

Table showing the food substances which the body usually requires in a day and the number of calories which may be obtained from them.

Concentrated Food. — Some persons think that there are foods which are so concentrated and nourishing that a teaspoonful of them mixed with a glass of water will supply the body with as much food substance as a full meal of bread and meat. This is not so. About a small teacupful of pure, dried protein is needed each day in order to rebuild the worn-out flesh, and nothing else will take the place of that quantity of protein.

The most concentrated fuel food is butter, or lard, and about a cupful of either one is needed to supply

the daily needs of the body. Two cupfuls of the purest and most concentrated food is the very least that will keep a person in good health.

A tablespoonful of meat extract, or beef tea, or peptonized food, does not contain any more nourishment than a tablespoonful of milk. These substances may have a value as medicines, but they have very little food value. The nourishment in any food consists in its protein, fat, and sugar or starch, and these substances must be in quantities that are measured by cupfuls rather than by spoonfuls.

Composition of Food. — If you know the composition of the various foods, you can tell what ones to choose in order to supply the needs of the body. Those who buy supplies for armies reckon the composition of the food so that they can buy the right amounts of protein, fat, and sugar to supply the needs of the soldiers. Farmers often choose the food for their cattle by means of tables of the compositions of different kinds of hay and grain. The table on the facing page shows the composition of common foods.

Balanced Diet. — The food which a person eats is called his *diet*. A day's supply of food for a man doing very light work will consist of about three ounces of flesh-forming proteins and with it so much fat and sugar or starch that the whole amount of food will furnish about twenty-four hundred calories of heat. The flesh-forming proteins will supply about one sixth of the total heat, and the fuel food will supply about five sixths.

FOODS	WATER PER CENT	PROTEIN PER CENT	FAT PER CENT	SUGAR OR STARCH PER CENT	MINERALS PER CENT	CALORIES IN EACH POUND
White flour	12.5	11.0	1.1	74.9	0.5	1695
Whole wheat flour . . .	11.4	13.8	1.9	71.9	1.0	1700
Corn meal	11.6	8.4	4.7	74.0	1.3	1760
Oatmeal	7.3	16.1	7.2	67.5	1.9	1870
Corn meal mush	60.7	5.5	4.8	27.5	1.5	825
White bread	29.9	8.9	4.1	56.0	1.1	1395
Rice, boiled	72.5	2.8	0.1	24.4	0.2	525
Dried lima beans	10.4	18.1	1.5	65.9	4.1	1665
Boiled potatoes	75.5	2.5	0.1	20.9	1.0	455
Tomatoes, fresh	94.3	0.9	0.4	3.9	0.5	105
Cooked beets	88.6	2.3	0.1	7.4	1.6	190
Fresh asparagus	94.0	1.8	0.2	3.3	0.7	105
Green corn, kernels . . .	75.4	3.1	1.1	19.7	0.7	480
Apples, sliced	84.6	0.4	0.5	14.2	0.3	300
Banana pulp	75.3	1.3	0.6	22.0	0.8	470
Peaches	89.4	0.7	0.1	9.4	0.4	195
Peanut, kernels	9.2	25.8	38.6	24.4	2.0	2440
Roast beef	48.2	22.3	28.2	0.0	1.3	1500
Lean ham, cooked	60.0	25.0	10.0	0.0	5.0	865
Dried beef	44.8	39.	5.	0.0	11.2	940
Chicken meat	74.8	21.5	2.5	0.0	1.2	500
Fresh codfish	80.	18.5	0.5	0.0	1.0	365
Salt codfish	53.5	21.5	0.3	0.0	24.7	420
Cooked bluefish	68.2	26.1	4.5	0.0	1.2	670
Canned crab meat	80.0	16.5	1.5	0.0	2.0	375
Hen's eggs	73.7	14.0	11.0	0.0	1.0	690
Oyster meat	88.3	6.0	1.3	3.3	1.1	230
Cow's milk	87.0	3.3	4.0	5.0	0.7	315
Cream cheese	34.2	25.9	33.7	2.4	3.8	1850
Butter	11.0	1.0	85.0	0.0	3.0	3285
Sponge cake	15.3	6.3	10.7	65.9	1.8	1795
Custard pie	62.4	4.2	6.3	26.1	1.0	825

Table showing the composition of common foods, and the number of calories produced by their oxidation.

A diet in which protein supplies about one sixth of the heat and energy is called a *balanced* diet.

Some foods contain a great deal of flesh-forming substances, and only small quantities of substances that are heat-producing. Examples of these kinds of food are lean meat and the whites of eggs. Other foods consist mostly of heat-producing substances. Examples of these kinds of food are potatoes and rice. A mixture of meat and potatoes would make a balanced diet, for each has an abundance of what the other lacks.

Most vegetable foods contain a great deal of sugar or starch, and only a small quantity of protein and fat. Most animal foods contain a great deal of protein and fat, and almost no sugar or starch. A mixture of vegetable and animal foods will usually form a balanced diet.

The Arithmetic of Dieting. — The following examples show how we may calculate the value of a food.

Example 1. How many calories will a pound of wheat bread produce?

From the table on p. 217 we find that bread is 8.9 per cent protein, 4.1 per cent fat, and 56.0 per cent starch. The number of ounces of protein in a pound of bread is 16 times 0.089, or 1.4 ounces. The number of calories which the protein will produce is 1.4 times 120, or 168 calories.

The number of ounces of fat in a pound of bread is 16 times 0.041, or 0.65 ounce. The number of calories

which the fat will produce is 0.65 times 240, or 156 calories.

The number of ounces of starch in a pound of bread is 16 times 0.56, or 8.96. The number of calories in the starch is 8.96 times 120, or 1075 calories.

The total number of calories in a pound of bread is therefore $168 + 156 + 1075$, or 1399 calories.

In like manner the number of calories given in the last column of the table on p. 217 may be calculated for each kind of food.

Example 2. If a person were to live on bread alone, how much would he need in a day?

We first calculate how much bread he should take in order to get three ounces of protein a day. From the table on p. 217 we find that about one eleventh of bread is protein. In order to get three ounces of protein, thirty-three ounces of bread, or about two pounds, will be needed. This is about a loaf and a half.

By looking at the table on p. 217 we find that a pound of bread will produce about 1395 calories. Two pounds, therefore, produce 2790 calories, which is slightly more than the body needs. If the amount of bread is lessened so as to produce 2400 calories, the quantity of protein will be lessened to about two and one half ounces, which is too little for the daily needs of the body. Bread alone is, therefore, not a perfectly balanced diet.

Example 3. If a person were to live on bread and butter, how much would he need in a day?

If butter is spread rather thin, it will weigh about one tenth as much as the bread. The thirty-three ounces of bread given in Example 1 will have about three and one half ounces of butter on it. From the table on p. 217 we find that a pound of butter contains almost no protein, but it produces 3285 calories. Therefore, three and one half ounces of butter will produce 718 calories. The total number of calories produced by the thirty-three ounces of bread and the three and one half ounces of butter will be 3508 calories.

The proper number of calories, or 2400, will be obtained from two thirds of thirty-three ounces of bread, or twenty-two ounces, and two thirds of three and one half ounces of butter, or about two and one half ounces. But in this quantity of bread and butter, there are only two ounces of protein, which is only two thirds as much as the body needs. A bread and butter diet is therefore not well balanced.

Example 4. If a person were to live on ham sandwiches, how much would he need in a day?

From Example 3, we find that thirty-three ounces of bread, spread with butter, will contain three ounces of protein, and will produce 3508 calories. About half a pound of lean boiled ham sliced thin will be used in making the bread and butter into sandwiches. From the table on p. 217 we can reckon that the ham will contain about two ounces of protein, and will produce about 432 calories. The sandwiches will therefore contain five ounces of protein, and will pro-

duce 3940 calories. Three fifths of the sandwiches will contain three ounces of protein, and will produce about 2400 calories. Sandwiches, therefore, make a well-balanced diet, and about one loaf of bread, made into ham sandwiches, is sufficient food for one person for a day.

QUESTIONS

Give a definition of food.

What are the uses of food?

What are the five useful substances which compose foods?

What substances does a flesh-forming food contain?

What substances do heat-producing foods contain?

What foods contain mineral substances?

Name some of the waste substances which are contained in food.

Give a reason why alcohol might be called a food.

Give some reasons why alcohol is not called a true food.

How much protein does a person need to eat each day?

What is a *calorie*?

How many calories of heat does the body need to produce in a day?

How many calories does an ounce of protein produce? an ounce of fat? an ounce of sugar? an ounce of starch?

Why is a teaspoonful of concentrated food a day not sufficient for a man?

What is a *balanced diet*?

Choose a day's supply of food which would form a balanced diet.

Look at the table on p. 217 and reckon how much potatoes and fresh codfish a person will need in a day if he uses no other food.

CHAPTER XXI

DIGESTION

Changes produced by Digestion. — There are many different forms of protein, fat, and sugar, but only one form of each can enter the blood and be of use to the various parts of the body. These forms of protein, fat, and sugar are seldom found in food before it is eaten, but they are produced by changes which take place in food after it has been swallowed. Changing food which has been eaten to forms which can enter the blood is called *digestion*.

Digestion changes all kinds of protein to a form which is usually called *peptone*. It changes starch and sugar to a form of sugar, called *grape sugar*. It divides fat into fine drops which float in water, forming a milky liquid called an *emulsion*. The water and minerals of food are not digested, but enter the blood in the form in which they are eaten.

Organs of Digestion. — Food is digested in a tube which begins at the mouth, and extends the whole length of the trunk of the body. The part of the digestive tube just back of the mouth is called the *pharynx*, and the next part of the tube is called the *esophagus*. The pharynx is a muscular box which squeezes food into

the esophagus at the beginning of an act of swallowing. The esophagus conducts the food into the stomach.

The stomach is so much larger than the rest of the digestive tube that it looks like a bag between the ends of two smaller tubes. It is composed of muscle, and holds about two quarts. It lies crosswise of the body, mostly on the left side between the ribs and the waist-line.

The part of the digestive tube which is next to the stomach is called the *intestine*. It is a thin, muscular tube, somewhat larger than a person's thumb, and about five times as long as his body. It lies in coils and nearly fills the lower part of the trunk of the body. Another name for the intestine is the *bowel*. The lower fifth of the intestine is two or three times as large as the upper four fifths, and is called the *large intestine*.

Fluids of Digestion. — The body digests food by dissolving it in liquids which are in the mouth, the stomach, and the intestine.

The liquid in the mouth is called the *saliva*. Its work is to change starch to grape sugar. It is produced by six organs called the *salivary* glands. Two of them lie in front of the ears, two under the sides of the lower jaw, and two under the front part of the tongue. These glands are swollen during the sickness called the mumps.

The digestive fluid in the stomach is called the *gastric juice*. Its work is to change protein to peptone. It is poured out by the lining of the stomach in the same

way that perspiration is poured out by the skin. It is formed in thousands of tiny glands which stand side by side, like pin pricks, in the mucous membrane of the stomach.

The fluids of the intestine are the intestinal juice, the pancreatic juice, and the bile. The intestinal juice



Gastric glands.

is produced by glands which lie in the mucous membrane of the intestine, and which are like the glands in the stomach.

The pancreas is a large gland which lies behind the stomach. It manufactures a liquid, called the *pancreatic juice*, which it sends into the upper part of the intestine through a small tube.

The liver is a large gland which lies under the ribs on the right side of the body. It produces a bitter, yellow liquid, called the *bile*, which flows into the intestine through the same tube that the pancreatic juice flows through.

The work of the mixture of liquids in the intestine is to change starch and sugar to grape sugar, and protein to peptone, and to make fats into an emulsion.

Thus the mouth begins the digestion of starch, the stomach begins the digestion of protein, and the intestine digests all kinds of food.

Time Required for Digestion. — Digestion begins almost as soon as food enters the mouth, and some of the food is ready to enter the blood within ten minutes after it has been swallowed. The stomach will usually be empty in about three hours after eating, but the digestion of food will continue for about six hours in the intestine.

Peristalsis. — The greater part of the flesh of the esophagus, stomach, and intestine consists of involuntary muscle (p. 76). The use of the muscle is to force the food down the digestive tube. It contracts in ring-like waves which run down the esophagus, stomach, and intestine, and force the food forward, just as if each wave were a ring running slowly down the digestive tube. This motion is called *peristalsis*. When food reaches any part of the digestive tube, peristalsis begins in that part, and the motion of the part usually stops as soon as food has passed it.

The stomach and intestine force the food onward with a slow and gentle motion that is not usually felt. But if the wrong kind of food is eaten, the muscles may act rapidly and forcibly in order to push the harmful food out of the body. The peristalsis then causes the kind of pain which is called *stomach ache*.

When a harmful kind of food is swallowed, the waves of peristalsis sometimes run backward and force the

food back into the mouth. This backward motion of food into the mouth is called *vomiting*.

Exercise during Digestion. — Digesting food requires the muscles of the stomach and intestine to work. If you exercise or study hard near a mealtime, you may use up your strength, and may not have strength left to digest your food properly. Take a few moments for rest after each meal.

Bacteria in the Intestine. — The intestine contains great numbers of living bacteria which are very much like the bacteria of decay outside of the body. They live upon that part of food which does not become digested, and as they grow, they cause the food to decay. The food is then as poisonous as it would have been if it had been spoiled when it was eaten. Most of the bad feelings which are caused by poor digestion are due to the decay of undigested food.

Chewing Food. — No one can control the digestion of food in the stomach and intestine, but the way in which a food is eaten has a great deal to do with the way in which it will be digested. If a food is eaten properly, it will usually be digested readily.

Grinding food to small bits in the mouth helps all the digestive fluids to dissolve it. A great deal of poor digestion comes from swallowing food in lumps which are too big for the digestive juices to dissolve easily. Chewing food is one of the most important steps in digestion, for it breaks the food into small pieces which the stomach and intestine can easily digest.

Mouth Digestion. — Another object of chewing food is to mix it with saliva. Each mouthful of food does not remain in the mouth long enough for much of its starch to be digested then, but the saliva continues to act for about half an hour after the food reaches the stomach. About half of the work of digesting starch to sugar may be done by the saliva, if food is eaten slowly.

The main part of the food usually eaten is starch. If starch is not digested by saliva, the intestine has to do double its own share of work to digest it. The food will then not digest well, and it will be the cause of headaches and stomach aches. If you chew soft food, such as oatmeal, long enough to mix it with saliva, you will help the stomach and intestine to digest it.

Eating Fast. — When you eat fast, you cannot chew your food well, or mix it with saliva. The stomach and intestine cannot do the work which the mouth should have done. If your food is not well digested in the mouth, a large part of it will escape digestion in the stomach and intestine. You will get no more nourishment from a large quantity of food eaten fast, than from a small quantity eaten slowly. A little food well digested is better than a great deal half digested. If you have only five minutes for eating, you will get about as much nourishment by eating slowly as by eating fast during that time. You cannot chew all your food well if you take less than fifteen minutes in eating a meal.

Drinking at Mealtimes. — Some kinds of foods, such as soup, contain a great deal of water, and other kinds, such as crackers, are very dry; yet you can easily digest both kinds. Taking water with a meal does not interfere with the digestion of food. You may safely drink water, or tea, or coffee with a meal, if you are thirsty. But drinking water in order to be able to swallow food rapidly is harmful to the digestive organs.

A very cold drink with a meal stops the action of the digestive juices until the water becomes warm. Hot drinks destroy the gastric juice, and prevent it from acting at all. Ice water and very hot drinks are both harmful to digestion.

Eating between Meals. — The muscles of the stomach and intestine become tired and need a rest, as the muscles of the arm do. The cells of the glands which produce the digestive juices also need to rest often. It is best to eat only at mealtimes, so that the stomach and intestine may have time to rest between meals.

How much to Eat. — The feeling of hunger is a natural guide by which you can tell when to eat, and how much food to take. Hunger is usually a safe guide if you eat slowly and chew your food well. But your hunger and your appetite will often lead you to eat wrongly if you eat rapidly or if you take food for the sake of its taste, or for the pleasure of eating. If you eat slowly and only at mealtime, you may safely eat enough to satisfy your natural hunger and appetite.

The Feelings and Digestion. — Your feelings have a great deal to do with the digestion of food. When you are hungry, the sight and smell of good food causes the saliva to flow into the mouth. If you enjoy the taste of food, the gastric juice will begin to flow into the stomach as soon as you begin to eat. But if you eat when you have no desire for food, or if the food has an unpleasant taste, or if you are sad or angry, neither the saliva nor the gastric juice will flow properly, and your food will not be well digested.

Politeness and good manners at table are great aids to digestion, for they make you happy and help you to enjoy your food. Other things which will help you to digest your food are good cooking, clean dishes, and pleasant conversation.

Rules for Eating. — Your stomach and intestine will usually digest all the food that you need if you eat it properly. Most persons who have indigestion have brought the sickness on themselves by eating either too rapidly, or too much, or too often. Their indigestion will usually stop, and their digestive organs will nearly always do their work well again, if they eat properly.

It is not hard to learn to eat properly. The rules of good table manners are merely rules for eating in a healthful way. That is, it is good manners to eat slowly, to chew the food well, to be cheerful at the table, and to follow all the other rules of healthful eating.

QUESTIONS

What is *digestion*?

What changes does digestion produce in protein? in sugar and starch? in fat? in water? in minerals?

Name the principal organs of digestion.

Describe the stomach.

Describe the intestine.

What is the *saliva*?

What changes in food are produced by digestion in the mouth?

What is the *gastric juice*?

How is the gastric juice formed?

What changes does the gastric juice produce in food?

What fluids digest food in the intestine?

In what organs is starch digested? protein? fat?

What is *peristalsis*?

How much time is required for mouth digestion? for stomach digestion? for digestion in the intestine?

What effects are produced by bacteria growing in the intestine?

How does chewing food well assist the stomach and intestine to digest food?

Why is it necessary to chew soft foods, such as oatmeal?

Give some reasons why you should eat slowly.

What way of drinking at a mealtime is harmful?

Why is eating between meals harmful?

How can you know how much to eat?

In what respect are the rules of good table manners also good rules for healthful eating?

CHAPTER XXII

ABSORPTION AND ASSIMILATION

Absorption of Food. — Digested food is a whitish liquid which looks like thin cream. It is mixed with the indigestible parts of the food and with many waste matters of the body. It is of no use to the body until after it has passed into the blood. Taking digested food into the blood is called *absorption*.

A large quantity of blood flows through a network of capillaries which lie very near the surface of the mucous membrane of the intestine. All that separates the food from the blood is a thin partition composed of a single layer of epithelial cells and the thin walls of the capillaries. This partition is as thin as tissue paper, and allows water, minerals, and digested protein and sugar to pass through it readily and enter the blood stream. The substances then pass through the veins to the liver, and then to the heart.

Osmosis. — The mingling of unlike liquids which are separated by a thin partition through which they may pass is called *osmosis*. The absorption of digested food into the blood is an example of osmosis. The following experiment will illustrate the process: —

Carefully remove some of the shell from the large end of an egg, taking care not to break the thin membrane which lines the shell. Set the broken end of the egg into a small glass of water, and make a small



An egg prepared to illustrate osmosis.

hole through both the shell and the lining in the upper end. A large amount of water will pass into the egg, and will cause the white of the egg to overflow through the upper hole within fifteen minutes. The force which causes water to flow through the membrane and into the egg is that of osmosis. A small quantity of substance from the egg will also pass into the water,

but it will be much less than the amount of water which passes into the egg.

Osmosis in the Intestine. — The epithelial cells of the intestine and the walls of the capillaries form a thin membrane which is like the lining of the eggshell. The force which causes digested food to pass through the membrane into the blood is that of osmosis. When

food is eaten, very little of it is in a form which can pass into the blood. One of the principal effects of digestion is to change food to forms that may readily pass into the blood by the process of osmosis.

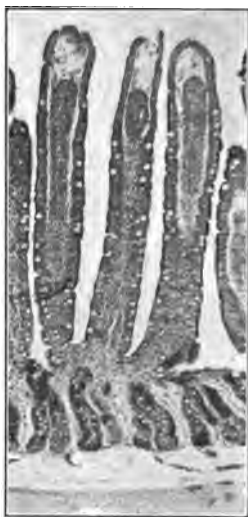
In some forms of poisoning, as that from decayed meat, the poisonous substances cause the direction of the flow in osmosis to be from the blood into the intestine. When this occurs, there is usually severe sickness and pain.

Other Examples of Osmosis. — The exchange of oxygen and carbon dioxide in the air sacs of the lungs, and of oxygen and waste substances between the capillaries and the cells of the body, are examples of osmosis.

Work of the Liver. — The cells of the liver remove the harmful substances which may have entered the blood with the food. They also take some kinds of excretions from the blood. The mixture of waste substances and excretions is the bile. If a person's liver does not do its work well, he will feel dull and sick, and will have what doctors used to call *biliousness*. Eating a great deal of sweet food is a common cause of biliousness.

Absorption of Fat. — Fat does not soak through the lining of the intestine in the way that oil soaks through paper, but it passes through the living cells of the epithelium in tiny drops. The cells do not pass the absorbed fat into the capillaries, but into lymph tubes, called *lacteals*. The lacteals unite in a large tube,

called the *thoracic duct*, which conducts the digested fat into a large vein near the heart.



Villi.

Villi. — The mucous membrane of the intestine is covered with tiny projections, called *villi*, which look like the short threads on velvet. Each villus contains a lacteal, and a great number of capillaries. The villi are like tiny fingers. They extend into the liquid food and take it up quickly.

What the Body does with Food.

— Putting digested food to use throughout the body is called *assimilation*. The blood carries a stream of digested food to every living part. Flesh that has lost some of its substance by oxidation

takes up protein, minerals, and water, and repairs itself with them. Glands take what they need in order to form their juices. Muscles take up sugar and fat, and oxidize them to produce heat and power. Each part of the body takes the substances which it needs.

Overeating. — The cells of the body will not use more food than they need, even though the blood brings a large quantity of food to them. Overeating may cause the body to store up great quantities of fat, but the fat is a weight which is often a burden instead of a help.

The cells of the body cannot use more food than they can oxidize. If a person sits still, or does very light work, he takes only a small quantity of oxygen into his body, and oxidizes only a small amount of food. If the blood takes up more food than the body can oxidize, some of the food will be half oxidized. The excretions will then be poisonous, and will cause headaches, rheumatic pains, biliousness, and kidney diseases. One of the principal causes of these forms of sickness is overeating. If you suffer from the effects of overeating, the cure is either to eat only a little food for a few days, or to take a great deal of exercise, in order to oxidize the extra food in your blood.

Growing Fat. — Thin persons often try to grow fat by eating all that they can. This will not always make them fat, for the food may not be digested, and the cells of the body may not make use of that which has been digested. But many persons gain flesh when they eat less food than usual, and eat it properly, for the food may then be well digested, and the cells may get the right kinds and amounts of food that they need.

Growing Thin. — A stout person can get rid of his fat by eating so little food that his body has to oxidize its fat. In order to get rid of ten pounds of fat in a month, a person must oxidize about five ounces of fat each day. Five ounces of fat will produce 1200 calories of heat, or about half the heat which a man's daily food produces (p. 214). If a person eats only half as much

food as he requires, his body will oxidize its fat, and he will become thin.

Another way of getting rid of the fat in the body is to take a great deal of hard exercise in order to compel the body to oxidize its fat.

What becomes of Undigested Food. — The parts of food which are not digested are slowly forced along the intestine, and are finally expelled from it. The intestine also expels the bile and other excretions which the liver has taken from the blood. Expelling waste matters and undigested food is the last act of digestion, and is as important to health as eating.

Some foods, such as vegetables and brown bread, contain strings and fibers which are like wood, and which do not become digested or decayed in the intestine. Harmless indigestible substances like these are necessary for health, for they help the peristalsis of the intestine.

QUESTIONS

What is *absorption*?

What are *villi*?

How does digested food pass into the blood?

What is *osmosis*?

How can you illustrate the process of osmosis?

What does the liver do to food after it is absorbed?

What is the *bile*?

Describe the absorption of fat.

Where is fat taken after it is absorbed?

What is *assimilation*?

What does the body do with food after it is absorbed?

What are some of the bad effects of overeating?

How can a thin person become fat?

How can a fat person become thin?

Why is some food which cannot be digested necessary for health?

CHAPTER XXIII

FOODSTUFFS

Cost of Food. — A simple way of supplying ourselves with food would be to go to a market and buy pure protein, fat, sugar, and starch, and then mix them in the proper quantities. But no one does this, for the mixtures which are made from the pure elements are nearly always tasteless and unwholesome. Our digestive organs need those mixtures of food elements which grow naturally in plants and animals.

The valuable parts of any food are the protein, fat, sugar, and starch that are in them. Sugar and starch may be bought for about six cents a pound, and fat for about twelve cents a pound. The cheapest protein costs about thirty cents a pound. If a food costs more than these prices, the extra price is for its taste and appearance, and not for its flesh-forming or fuel value. The grains have the greatest food value of all foods, and yet they cost the least. They are also foods which a person can eat day after day without tiring of them.

Oatmeal, $1\frac{1}{4}$ lb. @ 5 cents	\$0.06
Corn meal, $2\frac{1}{4}$ lb. @ 3 cents	0.07
Beans, 1 lb. @ 8 cents	0.08
Potatoes, 8 lb. @ 1 cent	0.08

Cheese, $\frac{3}{4}$ lb. @ 16 cents	\$0.12
Salt codfish, 1 lb. @ 15 cents	0.15
White bread, 2 lb. @ 6 cents	0.12
Fresh codfish, 1 lb. @ 14 cents	0.14
Beef, dried, $\frac{1}{2}$ lb. @ 40 cents	0.20
Beef, round, 1 lb. @ 20 cents	0.20
Hen's eggs, 1 doz. @ 20 cents	0.20
Cow's milk, 3 quarts @ 8 cents	0.24
Chicken meat, 1 lb. @ 30 cents	0.30
Beets, 10 lb. @ 5 cents	0.50
Oysters, 3 pints @ 20 cents	0.60
Bananas, 5 doz. @ 20 cents	1.00
Apples, 40 lb. @ 4 cents	1.60

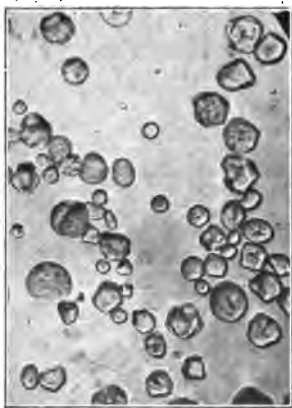
Table showing the cost of various foods, each of which will contain three ounces of protein.

Corn meal, $1\frac{1}{2}$ lb. @ 3 cents	\$0.05
Potatoes, 5 lb. @ 1 cent	0.05
Oatmeal, $1\frac{1}{4}$ lb. @ 5 cents	0.06
White bread, $1\frac{3}{4}$ lb. @ 6 cents	0.10
Beans, $1\frac{1}{2}$ lb. @ 8 cents	0.12
Cheese, $1\frac{1}{4}$ lb. @ 16 cents	0.20
Beef, round, $1\frac{1}{2}$ lb. @ 20 cents	0.30
Milk, 4 qt. @ 8 cents	0.32
Apples, 8 lb. @ 4 cents	0.32
Eggs, 2 doz. @ 20 cents	0.40
Bananas, 2 doz. @ 20 cents	0.40
Beets, 13 lb. @ 5 cents	0.65
Salt codfish, 6 lb. @ 15 cents	0.90
Fresh codfish, 7 lb. @ 14 cents	0.98
Beef, dried, $2\frac{1}{2}$ lb. at 40 cents	1.00
Chicken meat, 5 lb. @ 30 cents	1.50
Oysters, 10 pints @ 20 cents	2.00

Table showing the cost of various foods, each of which will produce 2400 calories of heat.

Food Groups. — The foods in grocery stores and butcher shops may be divided into about ten groups. These groups are cereals, beans, potatoes, garden vegetables, fruit, meat, fish, shellfish, eggs, and milk.

Cereals. — The different kinds of grain are called *cereals*. There are not great differences in the com-



Grains of cornstarch.

position and digestibility of the different kinds of grain, or in the flour which is made from them. All the cereals contain protein, and a great deal of starch. The only cereals which contain much fat are oats and corn.

Bread, oatmeal, and other foods made from grain are the most useful and important of all foods. A person can live on them alone if he chooses, for they form a fairly well-balanced diet (p. 218). Millions of people live almost wholly on rice.

Cereals are the cheapest of all foods. About five cents' worth of corn meal will supply all the food material that a man needs in a day.

Value of White Flour. — White flour is made by sifting the indigestible skins and coarse particles from the finer parts. Bread made from the best white flour is as nutritious as bread made from whole wheat, and it may be digested with greater ease.

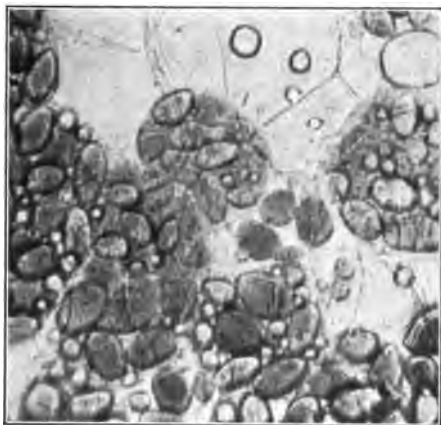
Bread. — Bread, biscuit, crackers, and plain cake are nearly alike in composition and digestibility. All these foods are full of bubbles, and are said to be *light*. The bubbles are made by carbon dioxide which is formed when yeast or baking powder is added to wet flour (p. 48). When the wet flour is baked, it hardens in the form of thin-walled bubbles, which may easily be chewed. Wheat flour may readily be made into light bread, for its protein becomes sticky when it is wet. The protein of corn meal does not become sticky, and so corn meal cannot be made into light bread unless it is mixed with wheat flour or eggs.

Beans and Peas. — Dried beans and peas are rich in protein and starch, but they contain very little fat. If they are cooked with fat pork, they become a well-balanced diet. They are not suited to persons who have weak stomachs, but they are excellent for hardy men who work out of doors, for in such persons the stomach usually grows strong with the muscles. They cost about eight cents a pound, and the protein and starch in them are nearly as cheap as in cereals.

Peanuts are a kind of pea whose pods are hard, like thin nutshells. They are like peas in composition, except that they have fat in the place of about half of the starch of peas. They cannot be digested easily, and if they are eaten between meals, they are as harmful as beans would be.

Most nuts are like peanuts in composition, digestibility, and food value.

Potatoes. — Potatoes are about four fifths water, one sixtieth protein, and one seventh starch. They



Starch grains in a thin slice of potato.

contain almost no fat at all, but if they are cooked with meat, as in a stew, the mixture becomes a well-balanced diet. When potatoes are dried, they have about the same food value as the least nourishing of the grains. They can-

not be digested so easily as cereals unless they are cooked for a long time.

The cost of potatoes varies greatly in different seasons of the year. When they may be bought for fifty cents per bushel, they are almost as cheap a food as cereals.

Garden Vegetables. — Garden vegetables, such as beets, onions, cabbage, and celery, are mostly water, and contain very little protein, starch, or sugar, and almost no fat. They have very little flesh-forming or fuel value. Yet if a person does not eat them at all, he becomes weak and sick, for they contain small amounts of iron and other substances which the body needs.

Crews of ships on long voyages used to suffer with a disease, called *scurvy*, in which the mouth and skin became tender and sore. The disease was caused principally by a lack of fresh vegetables, but now the disease is very rare, for fresh vegetables and fruit are carried in a canned or preserved form. Only a small quantity of vegetables is needed in order to prevent scurvy.

Most kinds of garden vegetables cannot be digested easily. By using them as side dishes, or as flavoring for other food, a person will take as much of them as his body needs. Protein and starch, in the form of turnips, cabbage, and green corn, cost about ten times as much as they do in the form of cereals.

Fruit. — Dates, bananas, and grapes, each contain a considerable amount of protein, and a large amount of sugar. Almost the only food substance in berries, apples, oranges, peaches, and most other juicy fruits is sugar. The skin and seeds of fruits cannot be digested at all, and the soft pulp cannot be digested so easily as cereal food. Most fruits have about the same food value as garden vegetables, and they can take the place of vegetables in a diet. They are more expensive than vegetables, and are far more expensive than cereals. Dried fruits contain all the food substances that are found in fresh fruits, and are far cheaper than the fresh fruits.

Meat. — The flesh of animals is called *meat*, but by the word *meat* we usually mean the flesh of beef cattle, pigs, sheep, and chickens. Meat is about one sixth

protein. Some kinds of meat contain a great deal of fat, and other kinds have very little fat, but no meat contains sugar or starch. The different kinds of meat, such as beef, pork, and chicken, do not differ greatly in composition, or ease of digestion, but there are great differences in their cost.

Some persons suppose that the expensive kinds of beef, such as sirloin steak, are more nourishing, and may be digested more easily, than the cheapest kinds, such as meat from the neck of an animal. This is not so. There is very little difference in the food values of the various kinds of beef. The principal difference is in the toughness and taste of the meat, but a good cook can make tough meat as tender and as tasty as the dearer kinds of meat.

Meat foods cost several times as much as cereal foods, but meat may usually be digested more easily than cereal food. A person can live a healthy life without meat ; but a mixture of meat with cereals, potatoes, beans, and other vegetable foods is usually more wholesome, and forms a more balanced diet than either vegetable food, or meat food alone would do.

Some persons suppose that a teaspoonful of beef tea, or of meat juice, or of meat extract, contains as much nourishment as a pound of beef. These liquid foods contain almost no nourishment at all, for the substances which have a food value cannot be dissolved from the meat. The principal value of meat teas and meat extracts is their taste (p. 212).

Fish. — The meat of fish is almost like the meat of cattle in composition and food value, except that it usually contains more water, and is less easy to digest. It differs from beef principally in its taste. If fish is well cooked, it may take the place of meat. Protein in the cheaper kinds of fish is almost as cheap as it is in cereals. Dried codfish is one of the cheapest of all the flesh-forming foods.

Shellfish. — Oysters, clams, lobsters, crabs, and other shellfish are like fish and meat, except that they usually contain a little sugar, and a great deal of water. The food substances in them are about three times more expensive than in meat.

Shellfish are usually taken from the bottom of bays and creeks. If sewage empties into the water near them, they are likely to carry disease germs on their shells and in their digestive tubes. But if the shellfish are cooked, the disease germs in them will be killed.

Eggs. — Eggs have about the same composition and food value as meat. They may usually be digested readily, whether they are raw or are cooked in any good way. Their ease of digestion depends principally on the size of the lumps which are swallowed. A raw egg may form a large mass which the digestive juices cannot readily enter. A hard-boiled egg may be quickly digested if it is chewed to small bits.

A dozen eggs weigh about a pound and a half. At twenty-four cents a dozen they have about the same

food value as a cheap form of meat, but at forty cents a dozen they are an expensive food.

Milk. — Cow's milk is a complete and well-balanced food, for it contains protein, fat, sugar, minerals, and water in nearly the quantities that the body needs. One eighth of it is solid substance, and a cup of it contains more solid food than a cup of oysters. A person doing light work would need no more food than four quarts of milk a day. It contains rather more protein than a grown person needs, but it is the best of all foods for young children, for they need a great deal of protein in forming new flesh while they grow in size. Milk at eight cents a quart is as cheap a food as cheap meat.

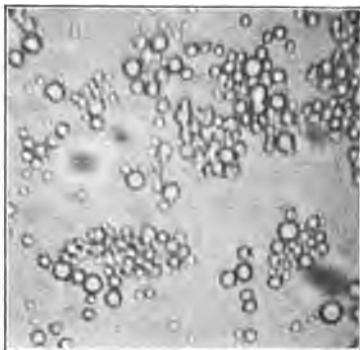
Milk may be digested readily, and it contains almost no indigestible substances at all. It is one of the most valuable of all foods for persons who are sick or have weak stomachs.

Some persons often drink milk instead of water when they are thirsty, and are not in need of food. Milk is a food as well as a drink. Taking it between meals or after a meal is as harmful as taking any other food when the body has no need of it.

Foods made from Milk. — The fat of milk is in tiny drops which float through its liquid and make it appear white. When the milk stands quietly for a few hours, the fat rises to the surface and forms a layer called *cream*. After the cream has been removed, the milk that is left is called *skim milk*.

Milk which contains a great deal of cream is called

rich milk; if it contains a small quantity of cream it is called *thin* milk. Many persons suppose that thin milk and skim milk are of little value as food. Thin milk and skim milk each contains about as much protein and sugar as rich milk. Taking the cream from milk does not spoil it for food, for nearly all the protein and sugar are left in the skim milk. The price of skim milk is only about half that of whole milk, but it has much more than half the food value of whole milk.



Fat drops in cream. *Magnified.*

Cream is about one fifth fat, and contains about as much protein and sugar as milk itself. When it is shaken or stirred, its fat collects into a solid lump called *butter*. The liquid that is left is called *buttermilk*, and has about the same food value as skim milk.

Cheese. — The protein of milk becomes solid when the milk is mixed with a substance, called *rennet*, which contains the digestive juice of a calf's stomach. When the solid protein is pressed into a mass it is called *cheese*. Most cheese also contains a large quantity of fat. The flavor of cheese is caused by bacteria which grow either in the milk, or in the cheese after it has stood for a few days or weeks. Cheese is one of

the most nourishing of all foods, and it may usually be digested easily. At fifteen cents a pound it is as cheap a food as cheap meat.

Tea and Coffee. — Tea and coffee are two drinks which most persons have on their tables. Tea is made from the dried leaves of the tea tree, and coffee is made from the roasted berries of the coffee tree. They each contain a substance, called *caffeine*, which keeps a person awake, and rouses his mind to work. Tea and coffee are stimulants, and do not supply the body with any food substance. The drinks are of value to grown persons who have to do hard work. They also have a great value in some forms of sickness, but they do more harm than good to children. If you cannot work or keep awake without them, there is something the matter with you, and neither of the drinks will be of any real help to you.

Cocoa. — Cocoa and chocolate are drinks which are made from the roasted seeds of the cacao tree. They each contain a substance which is like *caffeine*, only it is somewhat weaker. For this reason children can usually drink cocoa and chocolate more safely than tea or coffee.

QUESTIONS

What is the cost of a pound of sugar? of starch? of fat? of protein?

Name the principal food groups.

What are *cereals*?

What food elements do cereal foods contain?

What is *light* bread?

Why cannot corn meal alone be made into light bread?

If a man should live on corn meal alone, how much would a day's supply of food cost?

What food substances do dried beans and peas contain?

How much would a diet of dried beans cost a man daily?

For what class of persons are dried beans well suited?

What is the food value of peanuts?

What food substances are contained in potatoes?

How much would a diet of potatoes cost a man daily?

Why does a person need to eat garden vegetables?

How may scurvy be prevented?

What is the food value of fruit?

How do dried fruits compare with the fresh fruits in food value?

What food substances are found in meat?

How does meat differ from cereals in composition? in digestibility? in cost?

What is the principal difference between the expensive kinds of meat, and the cheaper kinds?

What food value has beef tea?

How do fish compare with meat in food value?

What is the difference in food value between shellfish and meat?

What food substances are found in eggs?

On what does the digestibility of eggs depend?

At what price per dozen would eggs be a cheap food?

What food substances are found in milk?

Why is milk one of the most valuable of all foods for children?

How much milk would a man doing hard work need to drink if he took no other food?

What is the objection to the use of milk to quench thirst?

What is the food value of cream? of skim milk? of buttermilk? of butter?

Of what food elements does cheese consist?

Why are coffee and tea called stimulants, and not foods?

What substance in tea and coffee is a stimulant?

Why is cocoa a better drink for children than tea and coffee?

CHAPTER XXIV

WHOLESOME FOOD

Storing Food. — Fruit, meat, and many other foods which naturally decay within a few days may be preserved for a long time if proper care is taken to prevent bacteria and molds from growing in them. Three ways of preserving foods in large quantities are by canning them, by drying them, and by putting them in cold storage.

Canned Foods. — Cooked foods will remain fresh for years if they are properly canned, for they are then protected from bacteria and molds (p. 39). Substances such as benzoate of soda are sometimes added to canned goods to keep them from spoiling. Coloring matter is sometimes added to preserve their appearance. If food is fresh, and is properly canned, it will retain its appearance and wholesomeness for years without the addition of preservatives.

Drying Food. — Fruits, vegetables, and meat will remain free from bacteria and molds, and will keep fresh, if they are dried and are then stored in a dry place. Food that has been properly dried and stored has the same food value that it had while it was fresh. Dried apples are cheap, and may be bought at any sea-

son of the year, and when cooked they have the same food value that they would have had if they had been cooked while they were fresh. The principal reason why dried fruit often has less food value than fresh fruit is that the best fruit is usually sold fresh, and the poorer fruit is dried.

Cold Storage. — Large quantities of meat, fish, eggs, and other food are preserved fresh for many months by storing them in rooms which are kept at about a freezing temperature. The cold prevents the growth of bacteria and molds, and also prevents other changes which would naturally take place in the food. The principal objects of cold storage are to preserve a food while it is taken long distances to market, and to store it safely while it is abundant in order that it may be used when a new supply of the food cannot be obtained. The meat and fish which are used in large cities usually come to market in cold storage cars, and are kept in cold storage until they are used. It would be almost impossible to supply a large city with food without cold storage.

All kinds of food that are not injured by the cold may be preserved in cold storage. If a food is poor in quality, or is spoiled when it is placed in cold storage, it will be in the same, or a worse, state when it is taken out. If it is fresh and wholesome when it is placed in cold storage, it will remain wholesome for months.

Keeping Food Fresh. — Many kinds of food, such as meat, milk, and cooked foods, usually turn sour, or

spoil, within a very few days after they are brought into the kitchen, or prepared for the table, unless great pains are taken to keep them fresh. Food will not decay or turn sour if no bacteria or molds grow in it (p. 39). There are three principal ways of keeping food from spoiling in a kitchen or pantry.

1. Food will not decay if it is kept dry, for bacteria will not grow without water. For this reason dry crackers will keep longer than bread, and dried beef will keep longer than fresh meat. Storing food in a dry place is a great help in keeping it fresh.

2. Food will not spoil if it is kept cold, for bacteria grow very slowly in cold places. Frozen meat will not spoil at all, but freezing will injure most vegetables and fruit. A cold cellar or an ice box is a great help in keeping food fresh.

3. If food is clean, it will have very few bacteria in it, and will keep fresh for a long time. Clean hands, clean dishes, a clean pantry, and keeping flies away from food, are all great helps in keeping food from spoiling.

Sour Milk. — Milk spoils and turns sour more readily than most other common foods. The souring is caused by bacteria which fall into the milk with dust and dirt. Some kinds of bacteria growing in milk produce a sour substance called *lactic acid*, which curdles the protein of the milk and makes it like jelly. The bacteria which turn milk sour are not usually harmful to grown persons, and do not spoil the milk for cooking.

But any milk that is about to turn sour, or that contains many bacteria, is dangerous for children and babies, for it usually contains bacteria which produce sickness.

Disease Germs in Milk. — Milk which contains harmful bacteria is the cause of over a quarter of all deaths among babies. Nearly all intestinal diseases among young children are due to unclean milk. Babies are more likely to have these diseases in summer than in winter, because most milk spoils quickly during warm weather, unless it is kept cool.

Any form of dirt in milk may contain disease germs. Scarlet fever, or diphtheria, or typhoid fever, may be spread along a whole milk route by means of milk which has come from a house in which some one is sick with the disease.



Milk from an unclean cow is not wholesome.

Wholesome Milk. — Wholesome milk means milk which is clean and almost free from bacteria. The dirt comes from dirty cows, dirty stables, and the dirty clothes and hands of the milkmen. Many farmers laugh when they are told about the good which would come from sweeping and scrubbing the cow stables, currying and brushing the cows, washing the hands and putting on clean clothes before milking, and carrying the milk at once to clean rooms. But these things



A clean cow.



A manure pile near a dairy is dangerous.

must be done if milk is to be wholesome. What is called *certified milk* in New York is pure because it is produced in this cleanly way. It is almost the only milk which may be safely fed to babies without first doing something to it to kill the germs (see frontispiece).

Some persons suppose that the harmful dirt may be strained from milk. This is not so. Thousands of

bacteria will be washed off from every speck of dirt as large as a grain of sand, and there is no way of removing them from the milk. If there is any dirt at all in the bottom of a milk pail or pitcher, or on the strainer, that milk is sure to be loaded with bacteria. It will not keep well, and will not be fit to be fed to small children, unless the bacteria in it are killed.

Dirt often falls into milk while it is being handled in open cans. The cleanest way of carrying milk to market is to place it in clean bottles as soon as it is milked, and then to seal the bottles, so that no dirt can get into them.

Buy your milk from a man who has clean stables, clean cows, clean milk cans, clean hands, and clean clothes. Put it in a clean pail or pitcher, and keep it in a clean place, and away from flies. Choose bottled milk, if possible.

Cooling Milk. — The number of bacteria in each drop of ordinary milk is several thousand while it is fresh, and is often many million after it has stood for a few hours in a warm room. The cleanest milk that may be bought or produced will have a few hundred bacteria in each drop. These will not usually do harm if they do not increase in number.

The easiest way to keep bacteria from growing is to cool the milk, for they will hardly grow at all if the milk is kept as cold as water in an ordinary well or pump. Those who produce wholesome milk cool it as soon as it is milked, and keep it cool until it is sold.

Buy milk which was cooled as soon as it was milked, and was kept cool until it was sold. Keep it in a cellar, or ice box, or other cool place.

Pasteurizing Milk. — Heating milk boiling hot will kill all the germs that may be in it. This is called *sterilizing* it. But a boiling heat changes its taste, and makes it less digestible than raw milk.

Heating milk to a temperature a little below boiling will kill nearly all the bacteria which may be in it. This is called *Pasteurizing* it. The heat does not change the taste or the digestibility of the milk. Pasteurized milk is a safe food for babies, if the milk is fresh when it is heated, and is afterwards kept cool and clean.

Food sold on the Streets. — Food which is sold from carts, or is placed in front of stores for show, often becomes soiled with dust and dirt from the street, and by flies which light upon it, and by the dirty hands of those who handle it. In all of these ways disease germs are often left upon food which is kept in front of stores. Do not buy food from these places, unless you afterwards cook it so as to kill all the disease germs which may be on it.

Adulterated Food. — Some foods which appear to be pure contain substances which are added to make poor goods appear to be of good quality. These foods are called *adulterated*. Milk is sometimes adulterated with water, coffee with chicory root, and olive oil with cottonseed oil. Benzoate of soda is often added to catchup in order to preserve it.

A great many medicines which are advertised as harmless contain harmful drugs. Nearly all pain killers and soothing sirups contain opium, most tonics contain as much alcohol as strong wine, and most headache cures contain substances, such as phenacetin, which produce dangerous weakness of the heart.

Pure Food Laws. — Deceiving people by selling adulterated foods and harmful drugs is a crime. Many countries and states have laws that all packages of foods and drugs that are sold shall be marked with a list of the substances which they contain. The object of the laws is to enable those who buy goods to know what kind of articles they are buying.



Grains of potato starch. *Magnified.*

Cooking. — The juices of the digestive organs cannot digest some kinds of foods readily unless the foods are cooked. Starch forms the principal part of grain and vegetables. The starch in each starch grain is in layers which are separated by thin sheets of an indigestible substance like paper. When food is cooked,

the heat makes the layers of starch swell, and causes the grains to burst open. The digestive juices can then reach the starch and easily digest it.

Much of the protein of meat and vegetables is in a tough, hard form which cannot be easily dissolved by the digestive juices. Cooking softens the protein, and makes the food so soft and tender that the digestive juices easily soak into it.

The fat in nearly all kinds of food is held in tiny pockets of protein (p. 30). Cooking softens the pockets, and sets the fat free.

Long Cooking. — Most kinds of food may be digested more readily when they are cooked than when they are raw. Very few kinds are made less digestible by long cooking. Most foods made from grain cannot be digested readily unless they have been cooked for at least an hour or two. Oatmeal may be soft and may taste good after it has been cooked for only fifteen minutes, but it will not be readily digested unless it has been cooked for some hours. A good way of preparing it for breakfast is to put it on to boil in the evening, and let it cook slowly all night.

Pancakes are usually hard to digest because they are cooked for only a short time. If they are cooked for ten or fifteen minutes, or if they are made from meal which has been cooked, they may be digested as easily as bread. Baked potatoes may usually be digested readily, because they are cooked for a long time and at a high temperature.

Stews. — When meat is cooked, some of its juices and fat run out. If the liquid is thrown away, much of the nourishment and a great deal of the best tasting parts of the meat are wasted. A good way of cooking meat is to make it into a stew or thick soup with potatoes and vegetables. This method saves all the nourishment that is in the raw food.

Another good way to cook meat is to place it in a hot oven for a few moments so that a crust will form over it quickly and prevent the juices from escaping. Then allow the oven to cool a little, so that the meat will cook slowly without burning.

Desserts. — Pie, cake, and pudding are cooked mixtures of flour, sugar, fat, eggs, and fruit, and are usually hard to digest. A person would soon get tired of them if he had to live on them alone. Their food value is that of the flour, eggs, and other things of which they are made.

Cooking and Disease Germs. — Food may contain disease germs which have come from dust or dirt, or from the milk or meat of diseased animals, or from house flies, or from other sources. If food is well cooked, the heat will kill all the disease germs that are in the food.

Food for the Sick. — Sick persons cannot digest food well. They need food which may be easily digested, and which contains very little indigestible substance. For this reason eggs, milk, and toast are usually the best kinds of food to use during sickness.

Learn to like these simple kinds of food so that, if you should be sick, you will be able to take the foods which are the best for you.

QUESTIONS

What is the cause of the spoiling of food ?

How does dryness help to preserve food from spoiling ?

How does a low temperature help to preserve food from spoiling ?

How does cleanliness help to preserve food from spoiling ?

Why do foods remain fresh when they are properly canned ?

How does drying affect the food value of fruit and vegetables ?

When food is properly kept in cold storage rooms, how is its food value affected ?

Name three ways in which food may be kept fresh in a kitchen or pantry.

What is the cause of the souring of milk ?

What is meant by *wholesome milk* ?

Where do the bacteria that are in milk come from ?

How may milk be produced almost free from bacteria ?

Why is bottled milk usually more wholesome than milk sold from large cans ?

Why is cold milk more likely to remain wholesome than warm milk ?

How is milk *Pasteurized* ?

Why is Pasteurized milk usually more wholesome for babies than raw milk ?

Why is food that is sold from stands on the streets likely to be unwholesome ?

What is an *adulterated* food ?

What is the object of pure food laws ?

What effect does cooking have on starch ?

What effect does cooking have on protein?

What effect does cooking have on fat?

What effect has long cooking on the digestibility of vegetable foods?

Why is a stew one of the most nourishing forms of cooked meat?

What effect does cooking have on disease germs that are in food?

CHAPTER XXV

CARE OF THE NOSE AND MOUTH

Bacteria in the Mouth. — The nose and the mouth are the gateways through which disease germs usually enter the body (p. 42). The care of the nose and mouth is of great importance in keeping the whole body well.

The mouth is warm and moist, and contains many substances on which bacteria may live. Many kinds of bacteria are always growing on the tongue and cheeks, and between the teeth. The bacteria often produce decay and bad odors. Disease germs also enter the mouth and grow there. Cleansing the mouth is very necessary for health.



Bacteria and an epithelial cell from the mouth.

Bacteria in the Nose. — Bacteria may always be found growing in the nose, but if the air passages are large and open, the mucus washes most of them away and prevents them from becoming great in num-

ber. If the air passages are stopped up, or if mucus is allowed to collect in them, large numbers of bacteria grow in the nose, just as they do in the mouth.

Most house dust that is breathed contains disease germs (p. 139). If the germs are allowed to lie in the nose, they may grow and produce colds and sore throats. Cleansing the nose is very necessary to health.

Bacteria in the Tonsils. — If the tonsils are enlarged, they nearly always contain numbers of deep holes and pockets (p. 129). These holes become filled with mucus, dead epithelium, and bits of food. Bacteria lie in them undisturbed, and cause the contents of the holes to decay. Disease germs also lodge in them and produce tonsillitis, sore throat, or other diseases. White spots about the size of pinheads may sometimes be seen on the tonsils. The spots are the outer ends of masses of decaying substances which fill the holes. Tonsils which are full of holes are dangerous to health, and should be removed by a surgeon.

Cleansing the Nose. — Blowing the nose will usually cleanse it. The mucus in the nose is a natural bath which washes away dirt and disease germs from the nose. Blowing the nose is necessary for its cleanliness, and for the health of the whole body. A clean handkerchief is a very necessary thing for every man, woman, and child to carry, and to use.

Sometimes the nose is stopped up by a swelling of its lining. Trying to blow the nose makes the swelling worse and increases the stoppage. The swelling will

usually go down if the breath is held as long as possible during expiration (p. 128).

Cleansing the Mouth. — Washing the mouth with water will cleanse it. Rinsing your mouth with water will not wash away thick mucus, or the coating from the tongue. Cleanse your tongue and the roof of your mouth two or three times a day by rubbing the parts just as you would cleanse the skin of your face. Use your fingers, or a swab, or a cloth, or, best of all, a toothbrush. By rubbing the mouth and tongue as far back as possible you will also cleanse the tonsils, and help to empty their holes and pockets.

Structure of Teeth. — A tooth is composed of a kind of hard bone called *dentine*, which is covered with a harder substance called *enamel*. The center of each tooth has a small hollow space containing nerves and blood tubes. The teeth are fixed in the bone of the jaw with a kind of soft bone called *cement*.

Decayed Teeth. — The teeth are likely to decay, unless they receive great care. The enamel of a tooth will seldom decay, for it is composed almost entirely of mineral substances. If the enamel is injured, the dentine under it readily decays and becomes soft. If the decayed part reaches the nerves, the tooth will ache.



A decayed tooth is the hiding place of disease germs.

Bacteria are the cause of decay in teeth, just as they are the cause of decay in dead substances (p. 37). They cannot pass through sound enamel, but they may enter the dentine through tiny cracks, and other injuries in the enamel. The cracks may be made by biting upon hard substances, such as nutshells. They are more often caused by sour substances which dissolve the minerals of the enamel. These harmful substances are formed when food and dirt are allowed to remain in the mouth. Keeping the teeth clean and free from dirt helps to preserve them.

Importance of Good Teeth. — Teeth that are dirty and decayed are unpleasant to look at. They are signs of a dirty mouth, a bad-smelling breath, and of disease germs in the body. But sound, white teeth are beautiful and pleasing. They are signs of cleanliness, a healthy mouth, and of freedom from disease germs.

Brushing the Teeth. — Cleanse your teeth with a toothbrush and water two or three times a day. Brush their inner surfaces as well as their front sides, and brush the back teeth as well as the front ones. Rub the brush up and down as well as sidewise, so that the bristles will reach between the teeth. Also rub the brush over your tongue to cleanse the whole inside of your mouth. Brushing your teeth and cleansing your mouth will help to keep your teeth from decaying, and will also help to prevent you from catching diseases.

A tooth powder or tooth paste is a useful article to

use in brushing your teeth. Many tooth powders contain chalk. This helps to scour the teeth clean, and also destroys the acids in the mouth. A soap that has no taste is also useful in cleansing the teeth and mouth.

Particles of food may become wedged between the teeth so tightly that a toothbrush will not remove them. Push them from between the teeth with a toothpick made of soft wood. One made of hard wood or metal may crack the enamel and start a hole in the tooth.

You may also remove food and dirt from between the teeth by passing a thread between them.

Decayed Teeth and Disease Germs. — When a tooth has a hole in it, all kinds of bacteria which may be in the mouth may lodge in the hole and grow there. Persons sometimes catch diphtheria, tonsillitis, and tuberculosis because a few germs of these diseases lodge in a decayed tooth and multiply there.

Filling Teeth. — You may save a decaying tooth by having a dentist remove the decayed part and fill the hole. The filling closes the hole and keeps bacteria from entering the dentine. Have a dentist examine your teeth every few months, and fill each hole as soon as it appears. In this way you can preserve your teeth for a lifetime.

Care of the First Set of Teeth. — Two sets of teeth grow in the mouth during a lifetime. Those of the first set begin to drop out when a child is about six years old, but the last of them do not drop out until he

is twelve or fourteen years old. Some of these first teeth are almost sure to decay. Few children have perfect sets of teeth.

Many persons think that the decay of the first teeth does no harm. Holes in the first set of teeth are as harmful to health, and are often as painful, as holes in the second set. The time for you to begin to care for your teeth is while you are young. It is as necessary for a three-year-old boy to brush his teeth as it is for a thirty-year-old man to brush his.

Sixth-year Molar. — In the first set of teeth there are only two double teeth on each side of each jaw. A



The teeth of an eight-year-old child.

The tooth on each end of the half circle is a sixth-year molar.

third double tooth appears behind the two when a child is about six years old. This tooth is the first tooth of the second set, and is called the *sixth-year molar*. Many persons suppose that it is one of the first set, and that another tooth will take its place. This tooth is the largest and most useful of all the double teeth, and if it is lost, no other tooth

will grow in its place. Take care of it, and have it filled if it shows any signs of decay.

Tartar on the Teeth. — A mineral substance called *tartar* often collects upon the teeth, and forms a hard, brown coating near the gums. This substance may push the gums away from the teeth, and may cause the teeth to become loose. Many grown persons lose

their front teeth because they allow the substance to remain on them. Brushing the teeth helps to keep the tartar from forming, but sometimes it is necessary to go to a dentist and have him scrape away the tartar next to the gums.

QUESTIONS

Why is cleanliness of the nose and mouth necessary for the health of the whole body?

What are the white spots which may often be seen on the tonsils?

What danger is there from tonsils which are full of holes?

Of what use is the mucus which is produced by the nose?

How may the nose be cleansed?

How does the use of a handkerchief affect the health of the body?

How may the mouth be cleansed?

Describe the structure of a tooth.

What is the cause of decay in a tooth?

How may the teeth be prevented from decaying?

Of what use is a tooth powder in brushing the teeth?

How do decayed teeth help to spread diseases?

If a tooth has begun to decay, how may it be saved?

How many sets of teeth grow in the mouth during a lifetime?

At what age does the first tooth of the second set appear?

In what part of the jaw should you look for the first tooth of the second set?

Why should a tooth of the first set be filled if it begins to decay?

What harm is done by the brown substance which often forms on teeth?

CHAPTER XXVI

INFECTIOUS DISEASES

Cause of Infectious Diseases. — Those forms of sickness that are caused by living germs growing in the body are called *infectious diseases* (p. 41). Some of the common infectious diseases are measles, scarlet fever, diphtheria, typhoid fever, and whooping cough. Each disease is caused by a particular kind of germ which is different from the germs of all other diseases. If we are not sure about the kind of disease which a person has, we can take some of the germs from his body and plant them in a glass tube, or in a lower animal, where they can multiply. We can then tell what kind of germs they are.

Fever. — Disease germs cause sickness by producing poisons called *toxins*. The toxins circulate in the blood and produce a fever (p. 153). A fever is nearly always caused by some form of toxin which is produced by bacteria.

Source of Disease Germs. — Germs of disease nearly always come only from some person or animal that has an infectious disease. We often say that they come from dirt and sewage, but no disease germs would be found in such things unless they were first put there.

If they are in dirt, or sewage, it is because they have escaped from a sick person or a sick animal. A pile of dirt, or a decaying garbage heap, or a foul cesspool, will not produce any kind of disease germ, unless that kind of germ is first planted in it.

There are no disease germs in healthy flesh and blood. A person will not have an infectious disease, unless disease germs which grow outside of his own body are put into it. Catching a disease means taking its germs into the body. Taking disease germs into the body is called *infection*.

How Disease Germs leave the Body. — Disease germs leave the body of a sick person in five ways. The four principal ways are through the intestine, bladder, nose, and mouth. These are also the principal gateways through which excretions leave the body (p. 173). Every excretion, except perspiration, from the body of a diseased person usually contains germs of the disease (p. 176). If all excretions from the sick were destroyed, disease germs could not reach other persons to infect them.

The fifth way in which disease germs pass off from the body is through sores on the skin. The germs very seldom pass off through a sound skin, but the skin often becomes soiled with mucus and saliva from the nose and mouth, and with the excretions from the intestine and kidneys, and so the perspiration and skin of a diseased person may also be the means of spreading diseases (p. 166).

Disease Germs and the Breath. — Disease germs do not pass off from the body with the breath during quiet breathing. But when a person coughs, or sneezes, or blows his nose, or spits, he usually expels little drops of mucus and saliva, and these may contain disease germs. If the drops become dried, the germs may float in the air with the dust of a room, and may make the air dangerous for breathing. Air which is foul and dusty may be the cause of spreading diseases (p. 139).

Disease germs also rise with the dust, if the floor contains saliva and other excretions from a diseased person. Most foul air is dusty, and contains disease germs which have risen with the dust.

It is almost impossible to find disease germs in the outdoor air, even a few feet from a person who has an infectious disease, or near a house in which he is sick.

Disease Germs and Dirt. — Dirt and filth will often contain disease germs, but not always. There are usually no disease germs in fresh ashes, or in the sand of the seashore, or in the dust of a flour mill, or in the mud of a mountain brook. The kind of dirt in which they will be found is the dirt made by the bodies of sick persons. Whatever is soiled by anything that comes from a diseased person's nose, mouth, intestine, or bladder, will contain the germs of the disease. The principal reason for keeping ourselves and everything about us clean is to be free from disease germs.

. Things which diseased persons handle often contain

the germs, but not always. If their hands are clean, there will be no germs on them, and they will not leave the germs on anything which they touch. But whatever diseased persons soil with the excretions from their bodies will contain disease germs. The germs will be found on soiled articles, such as clothes, bedding, towels, handkerchiefs, table dishes, and toys. If these things are boiled or washed well, the germs on them will be killed.

Most house flies are carriers of disease germs, because they are born in the excretions of the body, and because they usually live on filth (p. 198).

Impure water may be the means of spreading diseases if it contains excretions from diseased persons. When it is the cause of a disease, a great many persons in a town are usually made sick at the same time, for a number are likely to use the same water.

Weather and Diseases. — Many persons suppose that bad weather is often the cause of diseases. Hot weather helps the growth of bacteria in food and filth. When the weather is wet, or cold, or stormy, persons often stay in closed rooms where the air is foul and dusty, and contains disease germs. These are the principal ways in which the weather helps to cause sickness (p. 160).

How Disease Germs enter the Body. — The two gateways through which the germs of most diseases enter the body are the nose and the mouth. None of the germs of the common infectious diseases can enter

the body through a healthy skin, for the epidermis will keep them out if it is sound (p. 163). Diseased persons and their excretions may be handled with safety if there are no cuts, or scratches, or sores on the skin.

If the epidermis is injured or diseased, germs may pass through it and enter the blood and the lymph. This is the way in which the germs of pimples, boils, and sore wounds enter the flesh. Malaria and yellow fever are caused by germs which are put into the blood by the bites of mosquitoes. Hydrophobia is caused by germs which are put into the flesh by the teeth of dogs or cats which have the disease.

Contact with Diseased Persons. — Diseases are caught directly from sick persons themselves more often than in any other way. The sick often give the germs to others by kissing them, or by talking, sneezing, coughing, or laughing, while their faces are near the faces of others (p. 272). They also spread the germs to others by means of dishes, bedclothes, handkerchiefs, towels, and other articles which they use. Coming into close contact with diseased persons, or with toilet articles which they have recently used, is one of the principal causes of infectious diseases. But if the sick are clean and do not place their faces near your face, you are in very little danger of catching their diseases, even if you stand near them.

How the Body destroys Disease Germs. — Every person often takes disease germs into his body without

catching a disease, for the body can destroy the germs if only a few enter it. The body destroys disease germs in two ways. First, the white blood cells seize the germs and destroy them (p. 90).

Second, the liquid part of the blood contains substances which hinder, or prevent, the growth of the germs. Some persons have a larger quantity of these substances than others, and so they escape diseases which others catch. But nearly every person will take a disease if a great number of germs are put into his body at once. About a thousand germs must enter the body at one time in order that any of them may be able to grow and produce a disease.

The power of destroying disease germs in the body may be increased by anything which will increase the health of the body. Fresh air, good food, exercise, and proper rest are among the best of all means of protection against infectious diseases.

Immunity. — A person who has had measles, or scarlet fever, or chicken pox, or smallpox, or mumps, or whooping cough, or yellow fever, will not have the same disease a second time, even though he should take the germs into his body. As soon as a person catches one of these diseases and the germs begin to grow in the body, his blood begins to form a new substance, called an *antitoxin*, which destroys the toxins of the germs, and prevents those kinds of germs from growing. The body will afterward keep on forming the antitoxin of that disease during the rest of the person's

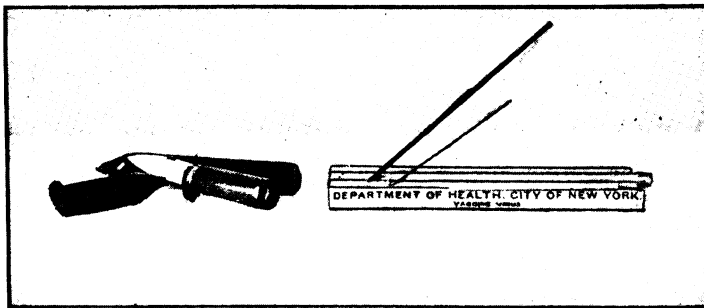
life, and no more of the germs of that disease will be able to grow in his body. If the germs of a disease will not grow in a person's body, we say that the person is *immune* to that disease.

Very few persons are naturally immune to any of the common diseases, for the blood does not begin to form the antitoxin against a particular disease until the germs of that disease begin to grow in the body. Nearly every child catches two or three kinds of diseases before he grows up, and is afterwards in no danger of taking those particular diseases again.

Vaccination. — Some germs of a disease are like weak seeds of a plant, and are hardly able to grow at all. If these weakened germs are placed in the body, they make very little growth and do not endanger health, but yet they cause the blood to form the antitoxin of the disease. Causing the body to form an antitoxin by means of weakened germs is called *vaccination*.

Vaccination for Smallpox. — Cows sometimes have a mild disease called *cowpox*. The germs of cowpox are like very weak germs of smallpox. When a person is vaccinated, a few of the germs from a calf are rubbed into a small scratch on his arm. The germs grow and cause a blister or sore to form on the spot. After two or three weeks the spot heals and leaves a scar. While the germs are growing in the flesh, they cause the blood to form an antitoxin which will remain in the body, and will prevent smallpox germs from grow-

ing if they should enter the body. One vaccination will usually protect a person from smallpox for many years, and often for a lifetime. The vaccinated persons who do take the disease have it very mildly. A good rule is to vaccinate every child when he begins to go to school, and again at about the age of twelve.



Vaccine.

Before the year 1800 smallpox was so common that everybody expected to have it, and more persons died from it than from any other disease. About that year vaccination was discovered by an English doctor named Edward Jenner, and was at once widely used. Since that time there has been less and less smallpox among civilized people. Every inhabitant of Germany is vaccinated, and smallpox is almost unknown in that country. Many people in the United States have not been vaccinated, and the United States has about a hundred times as much smallpox as Germany. There is almost no smallpox in New York city, because all

school children in the city and nearly all grown persons are vaccinated.

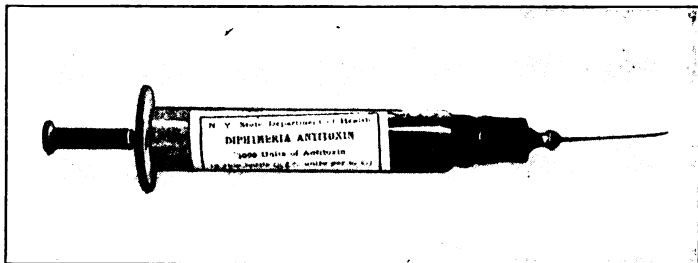
Some persons do not get vaccinated because they fear that the vaccination will produce a disease. If the arm is swollen, or if the vaccinated person is made sick, it is because dirt and disease germs were allowed to enter the vaccinated spot. Pure vaccine germs do not cause pain or sickness, and do not leave any harmful substance in the body. The vaccine that is now supplied by boards of health is pure, and is put up in sealed glass tubes. It is easy to put the vaccine into the arm in a clean and safe way. Disease germs may be kept out of a vaccination sore just as surely and readily as they may be kept out of drinking water, or out of a wound which a surgeon makes at an operation. If this is done, vaccination is safe, and does not produce any bad results.

Other Forms of Vaccination. — Vaccinations with the dead germs of typhoid fever are used for protection against typhoid fever. By using hydrophobia germs that are dead or greatly weakened, the body may be made immune to hydrophobia. Vaccines are also made for the cure of boils and pimples, and other forms of blood poisoning.

Diphtheria Antitoxin. — After the poisons of diphtheria germs have been injected repeatedly into a horse for about three months, the blood of that horse will contain a large amount of an antitoxin which will prevent diphtheria germs from growing in the animal.

Blood which is drawn from the horse will then contain large amounts of the antitoxin. This is the way of obtaining the antitoxin which is used for the prevention and cure of diphtheria in man.

Diphtheria antitoxin is not poisonous to man. If it is given before the diphtheria germs have nearly poisoned the body to death, it will cure the disease. Owing to its use, the number of persons who die from diphtheria is now only about one third as many as



Antitoxin for diphtheria.

before it was discovered. If the antitoxin is given to a well person, no diphtheria germs will be able to grow in his body until after two or three weeks. For this reason it is often given to nurses who care for the sick.

The antitoxins for lockjaw, meningitis, cholera, and snake bite poisoning are also manufactured.

Alcohol and Diseases. — Some persons take alcoholic liquors as a medicine, thinking that they will prevent a disease, or cure slight forms of sickness. Alcohol can neither prevent nor cure a sickness, for it weakens the whole body. It poisons the white blood cells, and pre-

vents them from destroying disease germs. A person who drinks is more likely to catch a disease than those who let alcohol alone. Drinkers who catch pneumonia, or typhoid fever, or other severe illness, are much more likely to die than those who do not drink. Surgeons fear to operate on those who are hard drinkers.

QUESTIONS

What is the cause of infectious diseases?

Name some of the common infectious diseases.

Where do the disease germs which are in dirt and sewage come from?

What is *infection*?

Through what four natural gateways do disease germs leave the body of a sick person?

Why do disease germs not leave the body through a sound skin?

When may the skin of a diseased person contain disease germs?

When may the expired breath of a diseased person contain the germs of his disease?

What are the two gateways by which disease germs usually enter the body?

Name some places in which you may expect to find disease germs.

When is the air likely to be the carrier of disease germs?

What has the weather to do with the spread of diseases?

What are *toxins*?

What is the usual cause of a fever in the body?

What substances in the body have the power of destroying disease germs?

What is *immunity*?

What is an *antitoxin*?

What is *vaccination*?

For what disease was vaccination first done?

How is a person vaccinated for smallpox?

How is the vaccine for smallpox made?

What has been the effect of vaccination on the spread of smallpox?

Name some other diseases for which vaccines are prepared.

How is diphtheria antitoxin prepared?

What has been the effect of the use of antitoxin in curing diphtheria?

Name some other diseases for which antitoxins are prepared.

What is the effect of alcohol on the power of the body to destroy disease germs?

CHAPTER XXVII

PREVENTION OF INFECTIOUS DISEASES

Means of Defense against Disease Germs. — Nearly all kinds of infectious diseases may be prevented. We know the source of their germs, how they enter the body, and how the body tries to destroy the germs which enter it. We have two methods of protecting ourselves against infectious diseases: first, by making our bodies as immune as possible to the germs which may enter them (p. 275); second, by preventing the germs from entering our bodies.

Disposal of Excretions. — The principal source of disease germs is the excretions from the bodies of persons who have the diseases. The proper disposal of all excretions, slops, and sewage would destroy nearly all disease germs before they could reach other persons.

Disease germs will be found in the excretions from the noses and throats of those who have infectious diseases. An excellent way to dispose of these excretions is to catch them on handkerchiefs which are to be boiled or burned as soon as they are soiled. Hold a handkerchief to the mouth and nose during coughing and sneezing, so as to catch the bits of liquid which fly off (p. 139). If a sick person is in bed, do

not tuck his handkerchief under a pillow, but lay it in a clean dish beside the bed.

Disinfection. — Destroying disease germs on an object is called *disinfection*. The face, hands, and skin of the sick person and the hands of the nurse may become soiled with excretions. Cleanse and disinfect them by washing them with soap and warm water as soon as they become soiled. Then dispose of the slops as you would the excretions of the intestine. Bathing and cleanliness of the sick are very necessary in preventing the spread of diseases (p. 166).

After you have cared for a diseased person, there will be disease germs on your hands. Wash your hands before you touch anything else. Do not touch your nose or mouth until your hands are clean.

The dishes, clothing, and towels which a sick person uses will be soiled with the excretions from the nose and mouth. An easy way to free the soiled articles from the germs is to boil them at once after using them. Keep a kettle of water boiling on a stove, ready to receive the soiled articles. Anything that has been boiled may be handled or used with safety, for the heat will kill all the disease germs that may have been on them.

Some persons suppose that it is dangerous to change the underclothing or bed sheets of a sick person. This is not so. Soiled clothes are dangerous to a sick person, for he may take the germs from them back into his own body. Change the clothing and sheets every day

or two, or as often as they become soiled. Keep the floors and everything else about the room clean, so as to remove all traces of the disease germs.

Fresh Air and Sunlight. — Some persons suppose that fresh air will make a sick person catch cold. This is not so. He will catch cold from disease germs, and the only air which contains them is that which is foul or dusty. Fresh air will help to prevent a person from taking cold, even though the air feels cool (p. 139).

Keep a window in the sick room open all day and all night, so that the sick person and those who care for him will not breathe disease germs. Keep the window shades up, and let the sunlight into the room, for the light, falling on disease germs, will kill them in a few minutes (p. 150). Place a screen in front of the sick person to protect him from uncomfortable drafts and his eyes from the bright glare of the sun.

Disinfectants. — Substances are often mixed with excretions, or dissolved in the water of the laundry or bath, in order to kill disease germs. A substance which will kill disease germs is called a *disinfectant*, or *antiseptic*. All disinfectants are poisonous to the body if they are swallowed.

One of the best of all disinfectants is a solution of *formaldehyde*. Another name for the solution is *formalin*. A tablespoonful of it is to be put into two or three pints of water, and used for washing the hands, floors, furniture, and soiled clothes and dishes, and for mixing with the excretions. It is not to be used for

washing the face for fear of harming the eyes and nose.

Another disinfectant is *carbolic acid*. It is a deadly poison. One or two tablespoonfuls of a weak solution, well mixed with a quart of water, may be used for washing the hands and soiled clothes and dishes.

A third disinfectant is *chloride of lime*. This is used principally for disinfecting excretions. It must be well mixed with the excretions before it will kill the bacteria in them.

Isolation. — There is always danger that disease germs may escape from a person who has an infectious disease. In many diseases it is necessary to keep the sick away from other persons. Keeping the sick away from well persons is called *isolation*.

When you have a cold or other infectious disease, stay away from school and other meeting places, and remain in a room by yourself. Do not sleep with other persons, or put your face near their faces. Use your own handkerchiefs and towels, and do not let any one else use them. Dispose of all the excretions from your body in a safe way.

If you are living in a house with some one who has measles, or scarlet fever, or diphtheria, or other bad form of infectious disease, stay away from school and other meeting places, because you may have already caught the disease and are ready to be sick with it.

Quarantine. — The germs of such diseases as scarlet fever, smallpox, and diphtheria are hard to kill. The

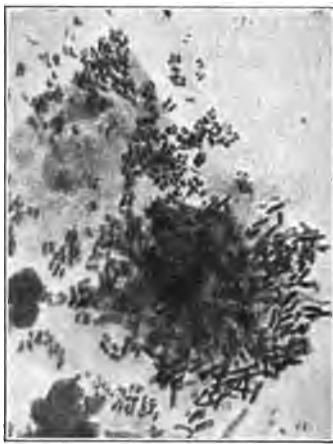
diseases are dangerous, and many lives are lost each year because of them. The laws require that the board of health of a town or city shall be told whenever any one in the place has one of these diseases. The health officer then visits the house, and gives orders that all persons except the nurses and doctors shall keep away from the sick person. The officer also instructs those in the house how to prevent the spread of the disease. He usually puts a notice on the house warning visitors to keep away from it.

Isolating a sick person and the house in which he is, by order of the health officers, is called *quarantine*. If the persons who are quarantined are poor, the health officer supplies them with food and other needful things at public expense.

At the end of the time of quarantine, the health officer sees that the rooms which have been used by the sick, and everything in them, are disinfected. This is done by cleaning them, and by either washing everything in them with a disinfectant, or filling the room full of a disinfecting gas.

Fumigation. — Disinfecting a room by means of a gas is called *fumigation*. The gas is usually made either by burning sulphur, or by vaporizing formalin. A large quantity of gas is needed in order to do any good at all. Five pounds of sulphur, or a pint of formalin, are needed for each 1000 cubic feet of space in the room, and the room must be tightly closed to prevent the escape of the gas.

Colds. — Any mild form of infectious disease is usually called a cold. Sore throat, tonsillitis, and what is called a cold in the nose, are all caused by disease germs which are caught from other sick persons (p. 270). The bad forms of colds, called *bronchitis*, and *pneumonia*, are caused by germs growing in the air tubes and lungs. Any form of cold may be caught from a person who has the disease.



Bacteria which cause a cold.

A cold is apt to be dangerous, for it weakens the body, and makes it likely to take other diseases easily.

If you have a cold, stay away from other persons, and destroy the excretions of your nose and mouth. If everybody did this, very few persons would catch cold.



Bacteria of diphtheria.

Mild Forms of a Disease. — Scarlet fever, diphtheria, small-pox, and most other infectious diseases are often so mild that the sick persons do not go to a doctor. Either they do not no-

tice any signs of the sickness on their bodies, or else they suppose that they have harmless colds. Yet these persons carry the germs of the disease, and may give the disease to others in a deadly form.

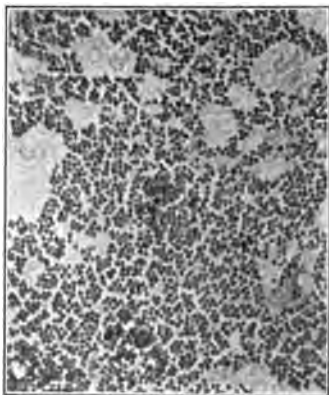


Bacteria of typhoid fever.

Sickness will spread from these mild forms of the diseases as readily as from the severe forms. Those who have one of these diseases in a mild form will spread the disease more readily than a person who is sick in bed, for those who seem to be well usually go among people, and often they take no care of their excretions.

Diphtheria. — In order to prevent a disease, we must be able to tell it when we see it. If a white patch, like a scab, is seen on the back part of the throat, that person has either diphtheria or

Many sore throats are either mild diphtheria, or scarlet fever, and sometimes what seems to be a mild chicken pox is smallpox in which only a dozen spots may appear on the skin.



Bacteria which cause boils and running sores.

tonsillitis. Sometimes the only sure way to tell the two diseases apart is to rub a small piece of cotton over the spot so as to get some of the disease germs from the throat, and then plant the germs in a glass tube. A growth of disease germs made in this way is called a *culture* (p. 270). By means of it we can tell what disease a person has.

Practice opening your mouth and letting some one press your tongue down with a spoon so as to see the back of your throat, for the only way of telling what ails you when your throat is sore is to look into it, or take a culture from it.

If you have diphtheria, the disease may be overcome by the use of antitoxin (p. 278).

Scarlet Fever. — If a person is suddenly taken sick with vomiting and a sore throat, and the next day the skin on his chest begins to be red, the sickness to think of is scarlet fever. If we are not sure what it is, we can tell in two or three weeks, for at that time the epidermis on the skin all over the body will begin to peel off if the disease is scarlet fever.

Scarlet fever is a dangerous form of sickness. Strict isolation, quarantine, and disinfection are necessary in every case, no matter how mild the sickness may be.

Some persons suppose that there is a difference between what is called scarlet rash and scarlet fever. A scarlet rash is merely a mild form of scarlet fever, and a person who has it may give a bad form of scarlet

fever to another person. Scarlatina is the name used in medical books for scarlet fever.

Measles. — Measles begins like a cold in the nose and eyes. After about four days the skin begins to break out in red blotches. The germs are given off from the nose and mouth from the very beginning of the disease, and the sickness is often spread to others before the sick persons know that they have the measles. The only way to stop the spread of the disease is to keep the sick persons at home and isolated as soon as they show signs of a cold in the nose and eyes.

Many persons suppose that measles is not a dangerous disease, and so they do not try to prevent its spread. Yet it causes more deaths than scarlet fever. Both it and scarlet fever often cause the kidneys, the eyes, and the ears to become diseased. Measles is the cause of dangerous forms of pneumonia in many persons.

Whooping Cough. — Whooping cough is often supposed to be a mild disease, but it is the cause of nearly as many deaths as scarlet fever, for it often causes diseases of the lungs. Keep every child who has it away from other children as long as he has the disease.

Hookworm Disease. — In the warmer parts of the United States there is a kind of sickness, called the *hookworm disease*, in which there is paleness and a great weakness that seems like laziness. The disease is caused by worms about a quarter of an inch long,

which live in the upper part of the intestine and suck blood from its mucous membrane.

The hookworm lays eggs which pass out with the excretions and hatch in the soil. The young worms are microscopic in size. They usually reach the intestine of the sick person by burrowing through the skin of his feet. The disease may be prevented by cleanliness and by proper disposal of excretions and sewage. It may be cured by the use of a medicine, called thymol, which will kill the worms in the intestine.

Typhoid Fever. — Typhoid fever is caused by the germs of the disease growing in the intestine. The germs enter the body through the mouth. The disease is spread by means of excretions from the sick, or of sewage containing their excretions. One of the principal causes of typhoid fever is water which has been made impure by excretions from the sick (p. 187). Another common cause is house flies which carry the germs from the sick, or their excretions, to the food on which they alight. Many persons catch typhoid fever from neglect to cleanse their hands after caring for the sick.

Some persons have a mild form of typhoid fever, but seem to have only a stomach ache which lasts for several days. These persons, working in kitchens and dairies, are sometimes the means of spreading the disease to others.

Disease Germs in Wounds. — If a wound is sore and a creamy liquid runs from it, we sometimes say that a person has taken cold in the wound. If the skin around

the sore spot is red and swollen, we sometimes say that he has blood poisoning. Taking cold in a wound, and blood poisoning, each means that disease germs are growing in a wound. Boils and pimples are caused by disease germs which enter the flesh through injured hair roots (p. 170).

Many persons and animals have small pimples and sore spots on their skin from which disease germs are allowed to escape, and so the disease germs that cause them are scattered in nearly every place where men and animals are found. They often grow in the mouths of the glands which produce perspiration and oil, but there they usually do little harm. But if the skin is wounded, they may enter the flesh and grow. The white blood cells try to kill the disease germs, but the disease germs usually kill many of the blood cells. The creamy liquid that runs from the sore spot is called *pus*, and consists principally of white blood cells which have been killed by the disease germs. Pus usually contains living disease germs.

Dressing a Wound. — If a wound contains no disease germs, it will quickly heal without pain or soreness. Covering a wound with a clean dressing will prevent germs from entering it.

The blood which flows from a wound will help to wash away dirt and disease germs. Washing a wound with clean water will also help to cleanse it. Always use water that has been boiled in order to kill the germs which may be in it.

A good form of dressing consists of clean cotton cloth torn in strips. A dressing may be made from old sheets or underclothing that have been washed and ironed. Packages of cloth already prepared for a dressing may be bought at drug stores. The prepared cotton called *absorbent cotton*, which is sold in drug stores, is one of the best forms of dressing.



An arm neatly bandaged.

If a wound is small, dress it by winding a strip of dressing round and round the part. If a wound is a large one, crumple up a bunch of dressing and lay it on the wound, and bind it in place with strips of bandage. Change the dressing daily.

Germs cannot grow readily in a wound which is dry, but they may grow readily in any liquid which runs from a wound. A dressing of cloth or cotton will soak up the liquid and the germs that are in it, and thus will prevent the growth of the germs.

Sticky salves and plasters are usually dangerous dressings, for they stick to the skin around a wound, and prevent the escape of pus and other liquids. When they are used, germs grow in the liquid under the salve, and make the wound red and sore.

A Wet Dressing. — If a wound is sore or contains pus, keep the dressing wet with water which contains

a disinfectant, in order to kill the germs which soak into the dressing. A teaspoonful of carbolic acid well mixed with a quart of clean boiled water makes a good liquid for wetting a dressing.

Lockjaw. — The disease called lockjaw, or *tetanus*, is caused by a kind of germ that enters the flesh through wounds. The tetanus germ is almost the only kind that will naturally grow outside of a living body. The germs may often be found in the soil of gardens and roads. They cannot grow in the body if air touches them, but they may readily grow in deep wounds, such as would be caused by a nail thrust deeply into the flesh. The germs are also likely to grow in burns made by fireworks, for the burned flesh keeps the air out of the deeper parts of the wound.

Lockjaw may usually be prevented by dressing a wound with clean dressings, and keeping the dressing soaking wet with a disinfectant, such as water containing carbolic acid. A dose of lockjaw antitoxin will prevent the growth of lockjaw germs, if any should enter a wound.

QUESTIONS

What is the principal source of disease germs?

What is a safe way of disposing of the excretions from the nose and throat?

What is disinfection?

How may the hands and skin of a sick person be disinfected?

How may the dishes and clothing of a sick person be disinfected?

Give some reasons why the underclothing and sheets of a sick person should be changed often.

What is the effect of sunlight on disease germs?

What is a disinfectant?

Name some good disinfectants.

How should formalin be used to kill disease germs?

How should carbolic acid be used?

How does the isolation of diseased persons prevent the spread of infectious diseases?

What harm may be done by visiting a person who has an infectious disease?

What is *quarantine*?

How does a health officer quarantine a house?

How should a room be disinfected at the end of a quarantine?

How should a room be fumigated in order to kill disease germs in it?

What is a *cold*?

What is the cause of a cold?

What is a great danger in extremely mild forms of infectious diseases?

What signs would make you think that a person has diphtheria?

What is a *culture*?

What are the signs by which scarlet fever may be recognized?

Why should mild cases of scarlet fever be quarantined?

When a person is coming down with measles, what signs does he show before his skin breaks out?

What dangerous forms of sickness are often caused by measles?

How is hookworm disease usually spread?

How is typhoid fever usually spread?

What is the cause of taking cold in wounds?

What is *pus*?

What is the reason for dressing a wound?

How should you dress a wound?

What is a wet dressing?

How does a wet dressing destroy disease germs which may be in a wound?

What is the cause of lockjaw?

How may lockjaw be prevented?

CHAPTER XXVIII

TUBERCULOSIS

Tuberculosis, the Modern Pestilence. — In former days, when little was known about the causes of diseases and their prevention, plagues and pestilences, such as smallpox, scarlet fever, and cholera, used to sweep over the land and kill large numbers of the inhabitants each year. We now know how to keep them from spreading, and have almost wiped out those diseases which come suddenly and kill quickly. Yet one great pestilence is still among us. Tuberculosis, or consumption, is a disease which now kills 125,000 persons each year in the United States, or more than the number of soldiers who were killed in battle during the Civil War. It is often called the great white plague, because it is very common among white races, and because those who have it become pale, and slowly waste away. One tenth of all deaths in the United States are due to it, and yet it may be prevented.

Bacteria of Tuberculosis. — Tuberculosis is caused by a kind of bacteria growing in the body. They grow in the lungs more often than in other organs, for they usually enter the body by means of air. They sometimes grow in the bones or joints, and there give

rise to forms of hip-joint disease, hunchback, and other troubles. They may also grow in the brain, the skin, the intestine, and in most other parts of the body. Tuberculosis of the lungs is usually called *consumption*.

Cows may have tuberculosis, and the germs may then be found in their milk. The flesh of diseased animals may also contain the germs. Government inspectors are sent to slaughterhouses to examine the animals that are killed, and to destroy meat which contains signs of the germs.

How Tuberculosis is Taken. — A person catches tuberculosis from some one else, or some animal, that has the disease. Very few of the germs are given off by the breath and by the skin of a consumptive person, but the phlegm that is spit out from the mouth contains them. Drying and freezing do not kill the bacteria, and when they are blown away as dust, another person may breathe them and catch the disease. The germs may be carried to food by house flies. The bacteria sometimes enter the body through pricks, or cuts, and also by means of milk or meat from cattle which have the disease.

The bacteria do not grow within the body of every one who breathes them, for in a strong, healthy body the white blood cells destroy them, and substances in the blood prevent their growth. But if a great number of the bacteria enter the body at one time, the blood may be unable to overcome them all. If the body is weakened by overwork, or by indigestion, or a cold,

or other sickness, the bacteria may grow, even though only a few enter the body.

Signs of Tuberculosis. — A person who has consumption has little pain and feels but little sickness at the beginning of the disease. He usually feels tired, loses weight and strength, and often supposes that his feelings are due to hard work. He usually coughs as if he had a cold. Consumption often comes on because the germs of a cold have weakened the body so much that the germs of tuberculosis can grow in it (p. 287). Having a cough for some weeks, and losing flesh and strength, are two common signs of consumption.

Another sign of consumption is a fever. A mild cold does not usually cause a fever, but if a person who seems to have had a cold for some weeks has a fever every afternoon, it is likely that he has germs of tuberculosis growing in his lungs.

Scrofula. — Children sometimes have a disease, called *scrofula*, in which the lymph glands of the neck become enlarged and form hard swellings. The swellings may become red and tender, and may contain pus. They are often caused by tuberculosis germs which enter the glands through the throat. Adenoids and enlarged tonsils are two common throat troubles which allow the germs to enter the flesh and the glands. If the disease is neglected, it may produce tuberculosis of the lungs.

Tuberculosis of Bones. — A bone or joint that has tuberculosis is swollen and tender, and the bone itself

becomes softened. A bone or joint that slowly becomes sore and swollen probably contains the germs of tuberculosis. The hip is a joint in which tuberculosis often occurs.

How Tuberculosis Germs are Spread. — If a person has consumption, the principal way in which germs of the disease leave the body is in the mucus, or phlegm, that is spit from the throat. This mucus is called *sputum*. Consumptive persons usually cough often, and spit up a great deal of sputum. Thousands of persons who have the disease spit upon public streets, and on the floors of workrooms. The germs become dried and float in the air as dust. For this reason the dust from city streets, and the air of poorly ventilated workrooms usually contain the germs of tuberculosis. Those who work day after day in crowded shops are almost sure to take germs of tuberculosis into their bodies, and these germs are likely to grow if the workmen are overworked or underfed.

Spitting. — Spitting on pavements and on floors is one of the principal means of spreading tuberculosis. Persons often have consumption without knowing that they have the disease, and so it is not safe for any one to spit on pavements and floors. Spitting on these places is so dangerous that the laws of most states and cities forbid it, and signs are posted in cars and public places telling of the punishment which may be given to those who break the law.

Disposal of Sputum. — If those who have consump-

tion will catch and destroy all their sputum, they may safely go among other persons. While they are away from home, they may catch the sputum in clean handkerchiefs which they may safely carry in waterproof pockets. They may then kill the germs by boiling the handkerchiefs when they get home. While the consumptive person is at home, he may catch his sputum in paper cups, and burn them at the close of the day.

Using a spittoon is almost as dangerous as spitting on the floor, for a spittoon cannot be cleaned, but flies may crawl over it and carry away the disease germs to other persons.

A consumptive person will often soil his face and hands with sputum. Cleanliness of the skin is of great importance in preventing the escape of the germs.

Contact with a Consumptive. — The most frequent way of catching tuberculosis is by taking the germs directly from a consumptive person by such means as kissing, sleeping in the same bed with the sick, drying the face on the same towel, and eating from the same dishes. The husbands, wives, and children of consumptive persons are more likely to catch consumption than others, for their faces often come close to the faces of the sick, and they often use the same toilet articles that the sick use. But consumptive persons may safely live among their families if they are cleanly, have their own toilet articles, and keep their faces a foot or two away from the faces of others (p. 272).

Protection against Tuberculosis. — You can protect yourself against tuberculosis in two ways: first, by preventing its germs from entering your body; and second, by keeping your body so healthy and strong that the germs will not grow in it if you should take a few into your body.

One means of preventing tuberculosis germs from entering your body is by guarding against coming into close contact with a consumptive person. Another way of preventing germs of tuberculosis from entering your body is by avoiding those things which contain the germs, such as public drinking cups (p. 194), toilet articles that have been used by other persons, impure milk (p. 255), and meat from diseased cattle (p. 298).

Any means which will make your body strong and healthy will also help it to overcome the germs of tuberculosis which may enter it. Some of these means are deep breathing (p. 122), exercise and rest (p. 83), and proper eating.

The germs of tuberculosis often enter the body by means of foul and dusty air which is breathed. Foul air is also one of the principal causes of weakness and poor health. By always breathing pure air, you may prevent tuberculosis germs from entering your body, and you may also help to make your body strong enough to overcome the germs. The chapter on ventilation is important in connection with the prevention of tuberculosis (p. 144).

Curing Tuberculosis. — Consumption may be cured if it is treated early. The signs of cured consumption may be found in over half of the bodies which are examined after death. Many persons get well from consumption, and never know that they have had the disease.

Fresh Air. — One of the most important of all things in curing consumption is fresh air all the time, day and night. The sick must have it even if the air is cold. Cold air is not dangerous. It is not even uncomfortable if plenty of clothing is worn. In those hospitals in which the greatest number of consumptives get well, the sick live out of doors all day, and sleep in tents or porches which are wide open to the air.



A sleeping porch.

Sleeping tents are made in which the consumptive's head lies in an open window while his body is in the room.

Good Food. — Another thing which will help a consumptive person to get well is good food. He cannot build flesh and strength out of medicines, or out of anything else than food. He needs all the good food that he can digest, but no more. Overfeeding is as harmful to a consumptive as to a healthy person. He needs meat, eggs, milk, and other foods that may be easily digested, and are also rich in protein, for he must build new flesh like a child (p. 211).

Rest. — A third thing which a consumptive person needs is rest, for he needs all his strength to overcome the germs of the disease. A little exercise is helpful, but the sick person must not get tired.

A great many persons die of consumption because they do not stop hard work when they begin to be sick. They may safely do as much work as their strength will allow without their becoming tired.

Care of Sputum. — A fourth thing which a consumptive person must do in order to get well is to destroy the germs in his sputum. A person who has consumption will start the germs growing in new parts of his lungs, or flesh, if he takes them back into his body. Many fail to get well because they are uncleanly and do not take care of their sputum. Sunshine in the room, and cleanliness of the floors and furniture, are also necessary in order to kill all the germs that are in the sick room.

Teaching about Tuberculosis. — If all persons understood the nature of tuberculosis, they would try to

cure themselves early in the disease. One of the most important steps in both the prevention and the cure of the disease is teaching every person about it. Many cities and states have societies which send out printed instructions about consumption. Some states have exhibitions of charts, pictures, and models, showing how the disease may be prevented and cured.

Sanatoriums. — Many cities and counties have hospitals and sanatoriums for the care of persons who have consumption. One of the most valuable uses of these places is to teach the sick how to breathe, how to eat, how to exercise, and how to live in the best way to get well and stay healthy.

QUESTIONS

Why is tuberculosis called the great white plague?

Out of every one hundred deaths how many are caused by tuberculosis?

What is the cause of tuberculosis?

If a person has tuberculosis, from what part of the body does he give off the germs of the disease?

How do tuberculosis germs usually enter the body of a well person?

What are some of the first signs that appear when a person has tuberculosis?

What is *scrofula*?

How are tuberculosis germs usually spread?

What harm is done by spitting on pavements and floors?

How can a person who has tuberculosis destroy the germs in his sputum?

How may the germs of tuberculosis be prevented from entering the body?

How may the germs of tuberculosis be prevented from growing in the body after they have entered it?

Name some things which will aid in the cure of tuberculosis.

Of what use is fresh air in curing tuberculosis?

How much food does a person who has tuberculosis need to eat?

Of what use is rest in the cure of tuberculosis?

Why is the destruction of the sputum necessary in curing a person of tuberculosis?

Give some reasons why every person should learn about the prevention and cure of tuberculosis.

CHAPTER XXIX

THE NERVOUS SYSTEM

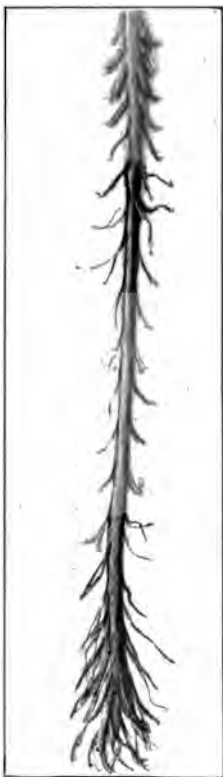
Need of a Nervous System. — Every part of the body must have help from other parts in order to live. The arm cannot live unless it receives blood from the heart, food from the stomach, and oxygen from the lungs; and it cannot work unless it receives orders from the brain. Each organ must help all the rest of the body, and so it must receive directions telling it when to act, and how much to do. The work of directing the actions of the different organs of the body is done by the organs of the central nervous system.

Central Nervous System. — The principal organs of the central nervous system are the *brain* and the *spinal cord*. The brain fills the top of the skull above the eyes and ears. The spinal cord is about as large around as a little finger, and is about half as long as the backbone. It hangs in-



Human brain, side view.

side of the backbone, and extends from the brain about to the waistline. The brain and the spinal cord are almost as soft as jelly; but they are protected from injury by the heavy bones of the skull and the backbone.



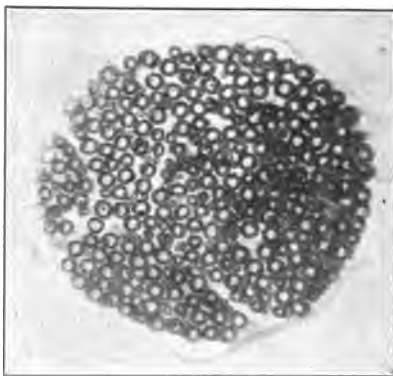
Spinal cord.

Nerves. — The brain and spinal cord are connected with all the other organs of the body by threads of flesh called *nerves*. Twelve pairs of nerves are joined to the lower part of the brain, and thirty-one pairs are joined to the spinal cord. The use of nerves is to carry messages between the organs of the body and the central nervous system.

Nerves are like telephone wires. The stomach, lungs, muscles, skin, and all other parts of the body, are like customers who have telephones in their stores and houses. The brain and spinal cord are like central telephone stations which the customers call up when they wish to send messages. Nerves do not run directly from one organ to another, but nearly all messages between the organs pass through either the spinal cord or the brain.

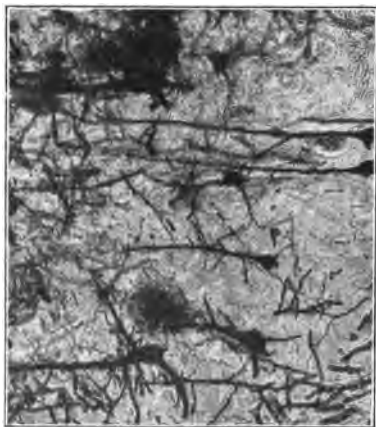
Nerve Cells. — The parts of the brain and spinal

cord that receive and send messages are called *nerve cells*. The nerve cells are so small that they cannot be seen without a microscope. They have small bodies and long branching arms. Some of these branches are the nerves which go to all parts of the



A nerve cut across.

body. Other branches of the cells extend to other nerve cells. The nerve cells are like the operators in a central telephone station. Their use is to receive and to send messages which pass between the different parts of the body.



Nerve cells of the brain.

The brain and the spinal cord consist of nerve cells and nerves. That part which contains nerve cells is reddish gray in color, and is called *gray matter*. That part of the brain and spinal cord which consists of nerves is white in color, and is called *white matter*.

Gray matter covers the outer part of the brain, but it forms the central part of the spinal cord. Some collections of gray matter also lie in the lower part of the brain.

Motor Nerve Messages. — Most of the messages which nerve cells send out are orders to do something. Any nerve which carries messages away from the central nervous system is called a *motor* nerve. There are four principal kinds of motor nerve messages.

1. Some of the motor messages are orders for the cells all over the body to take food and grow. When a muscle is exercised, it grows large because the spinal cord sends orders for it to take a large quantity of food from the blood in order to do its work well.

2. Some of the motor messages are orders for the glands to secrete their liquids. When the stomach receives food, the spinal cord sends orders for the glands to manufacture gastric juice.

3. Some of the motor messages are orders for the involuntary muscles to contract. When cold air strikes the skin, the spinal cord sends orders for the muscles of the arteries to contract, so as to keep the blood away from the skin.

4. Some of the motor messages are orders for voluntary muscles to contract (p. 81). Every motion of a muscle is ordered by the nerve cells. If no orders reach the muscles, a person cannot move, and we say that he is *paralyzed*.

Sensory Nerve Messages. — The messages which

the organs send to the brain and spinal cord are called *sensory* nerve messages, because many of them produce feelings or sensations. One class of sensory messages are those by which the organs tell of their need for food, or oxygen, or rest. After hard exercise the feeling of shortness of breath is the message by which the muscles tell the brain of their need of oxygen. If it were not for the sensory nerve messages, the brain and spinal cord would not know what orders to send to the various organs.

Other messages that the organs of the body send to the brain are those telling about things which are outside of the body. These messages are sensations of touch, sight, hearing, smelling, and tasting, and are called the *five senses*.

If something which is touching the body harms it, the feeling which is produced is one of pain in the injured spot. Pain is often a useful feeling, for it gives warning of danger to the body.

Conscious Nerve Actions. — Nerve actions may be divided into two classes: first, those which may be felt, called *conscious nerve actions*; and second, those which may not be felt, called *unconscious nerve actions*.

We are usually conscious of only two kinds of nerve actions: first, the motor messages to the voluntary muscles; and second, the sensory messages which the brain receives through the five senses. Nearly all other nerve messages are sent and received without our knowledge. For example, we are usually conscious of

sending orders for the movements of our arms and legs, and receiving messages of sight and hearing; but we are not conscious of the messages which order the flow of gastric juice, or of the messages by which the muscles tell of their need of food. The number of unconscious nerve actions is far greater than those of which we are conscious.

The nerve messages of which we are conscious are either received by, or are sent from, the nerve cells of the gray matter in the upper part of the brain. We therefore say that the upper part of the brain is the seat of *consciousness*, and of the mind. These cells do the work of thinking, and send out the orders for voluntary movements.

Unconscious Nerve Actions. — The messages which control the acts of secretion and growth, and the movements of the voluntary muscles, are either received by, or are sent out from, the nerve cells in the spinal cord and in the lower part of the brain. These actions are not under the control of the mind, but they go on whether a person thinks about them or not, and whether he is asleep or awake.

When the nerve cells of the upper part of the brain are injured, as by a blow on the top of the head, a person is unconscious, like one in a deep sleep. But life, growth, and repair of the body may still go on if the nerve cells of the spinal cord and lower part of the brain are in good order.

Relation of Brain and Spinal Cord. — The gray mat-

ter of the outer part of the brain is like a man who drives an automobile, but does not repair the car, or keep it in order. The work which the driver does is like the conscious work of the brain.

The gray matter of the lower part of the brain, and that of the spinal cord, is like a workman who sees that the car is repaired and kept in good order, but does not run the car. The work which the repair man does is like the unconscious work of the spinal cord and the brain.

The Spinal Cord and Voluntary Movements. — The cells of the spinal cord and of the lower part of the brain usually act only in answer to messages which they receive from some other part of the body. Some of the messages telling them to act come from the nerve cells of the upper part of the brain. When a person wishes to move a muscle, the cells of his brain send an order to the cells of the spinal cord, and they repeat the message to the muscles.

Reflex Action of the Spinal Cord.

— The cells of the spinal cord often send out orders in answer to sensory messages which they receive from the organs of the body. When a person pricks his finger

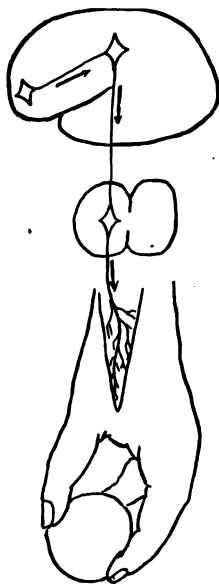


Diagram of the course of nerve messages in voluntary action.

with a tack, the finger sends a sensory message of pain which passes through the spinal cord on its way to the brain. The cells of the spinal cord at once reply to the message by ordering the muscles of the arm to take the hand away from the tack, and the finger is already snatched away from danger by the time the message of pain reaches the brain.

Sending a motor nerve message as a result of a sensory message is called *reflex action*, because the sensory

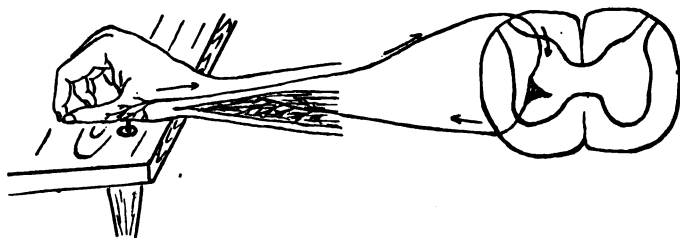


Diagram of the course of nerve messages in reflex action.

message seems to be reflected, or turned back, as a motor message.

Nearly all the messages for secretion and growth, and for movements of involuntary muscles, are reflex messages. For example, the cells of the spinal cord do not send orders for the stomach glands to produce gastric juice until they receive word that food is in the stomach. They order the arteries of the skin to contract when they get a message that something cold is touching the skin.

Sympathetic Nervous System. — The spinal cord

does a great deal of its work with the assistance of sets of nerve cells called *ganglia*. The principal ganglia are arranged in a double row of twenty-three pairs down the whole length of the backbone. They are about the size of grains of wheat or oats, and are connected with the spinal cord by means of nerves. Other nerves go from them to the arteries, and to the organs of digestion, respiration, and excretion. The ganglia and their nerves form what is called the *sympathetic* nervous system.

The ganglia send orders to the organs to do those kinds of work which go on slowly and steadily, such as the contraction of the arteries, the peristalsis of the stomach and intestine, and the secretion of saliva and gastric juice. They have very little nerve power of their own, but they get most of their power from the spinal cord. The spinal cord itself acts in a quick and forcible way, as in its reflex action when the finger touches a tack. The ganglia slow down the messages of the spinal cord and send them out in a gentle and continuous stream. For this reason the actions on which life depends, such as digestion, circulation, and excretion, go on slowly and regularly, and are not readily disturbed.

A disorder of any part of the body affects other parts through the sympathetic nervous system. For example, those who have eye troubles often suffer with headaches and stomach sickness. Adenoids in the throat interfere with the growth and strength of the whole body,

even though they do not produce pain or a feeling of sickness. A weakness of any part of the body may prevent other parts from being strong. Do not neglect a weakness or disorder in any part of your body.

QUESTIONS

- Why does a person need a nervous system?
- What are the principal organs of the nervous system?
- Where is the brain situated?
- Where is the spinal cord situated?
- Where are nerves found?
- Compare nerves with telephone wires.
- What are nerve cells?
- Where are nerve cells found?
- What is the gray matter in the central nervous system?
- Of what is the white matter of the central nervous system composed?
- What are motor nerves?
- What are some of the messages that are carried by motor nerves?
- What are sensory nerves?
- What are some of the messages that are carried by sensory nerves?
- What are conscious nerve messages?
- Name some nerve messages of which a person is conscious.
- Name some unconscious nerve messages.
- What is reflex nerve action?
- Explain the nerve action which takes place when a person jumps after pricking his finger with a tack.
- What part does the spinal cord take in conscious nerve acts?
- Where is the sympathetic nervous system found?

Of what does the sympathetic nervous system consist?

Over what actions does the sympathetic nervous system have control?

Where does the sympathetic nervous system get its power to act?

Why does a disorder of a single organ affect the whole body?

CHAPTER XXX

THE BRAIN

The Three Parts of the Brain. — The part of the central nervous system which is inside of the skull is called the brain. The greater part of the brain is a



Human brain, underside.

large mass which fills almost all the space under the rounded top of the skull. This part is called the *cerebrum*. Under its hinder end is a smaller mass called the *cerebellum*.

A slender stem of nerve matter from the cerebrum and cerebellum extends downward, and is continued outside of the skull into the backbone. The part of the nerve stem which lies inside of the skull is called the *medulla*. That part of the stem which lies outside of the skull is the spinal cord.

The brain, spinal cord, and nerves may be compared to a tree. The spinal cord and the medulla are like

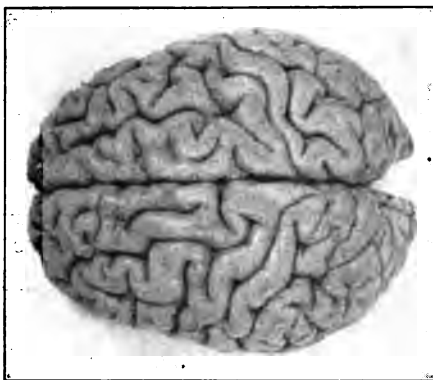
the tree trunk. The nerves which go from the spinal cord to all parts of the body are like the roots of the tree. The cerebellum and cerebrum are like the rounded top of the tree.

The Medulla. — A person's medulla is about as wide and half as long as his little finger. Nerves extend from it to all parts of the head and neck, just as nerves from the spinal cord extend to all other parts of the body.

The white matter of the medulla consists of nerve threads which join the cerebrum and cerebellum to the spinal cord. Some of the nerve cells of the gray matter of the medulla control the motions of the muscles of the head and neck, and other cells have some control over the heart.

A small group of nerve cells which lie near the center of the medulla within a space about the size of a pea have control over the movements of breathing. If these cells were destroyed, breathing would stop at once, and death would occur almost instantly. This part of the medulla is sometimes called the seat of life.

The Cerebellum. — The cerebellum is about the size of a large hen's egg. Its outer part consists of gray matter whose cells control the movements of the muscles in balancing the body, as in standing or running. The cells also cause the muscles of the body to act in a regular and orderly manner when making a number of quick and exact motions, as in playing a piano.



Human brain, upper surface.

The Cerebrum.

— The cerebrum is about five times as large as all the rest of the central nervous system put together. It covers the rest of the brain, and is the only part which is seen when the rounded top of

the skull is removed. It consists of gray matter covering a central mass of white matter. The cells of the gray matter are the seat of the mind, and of conscious nerve action (p. 311).

The white matter consists of nerve threads which connect the nerve cells with each other and with the rest of the body.

The surface of the cerebrum is folded and crumpled, and looks as if its covering of gray matter were too large for it.



Human brain cut in two crosswise.

Because of the folding, the amount of gray matter is about three times as much as it would be if the brain were smooth. A child is born with a very few folds on its brain, but as its mind grows, the folds on its cerebrum also grow in number and size.

The Work of the Mind. — The mind acts by means of the nerve cells of the cerebrum. These cells do three kinds of work: first, they receive sensory messages by means of the five senses (p. 311); second, they send out motor messages to the voluntary muscles; and third, they think.

Each part of the brain has one kind of work to do. The cells in the part of the cerebrum behind the ears receive messages through the five senses. Those just above and in front of the ears send out orders for moving the voluntary muscles. Those in the front part of the cerebrum do most of the work which is called thinking.

Memory and Thinking. — The nerve cells of the cerebrum keep a record of the messages which they

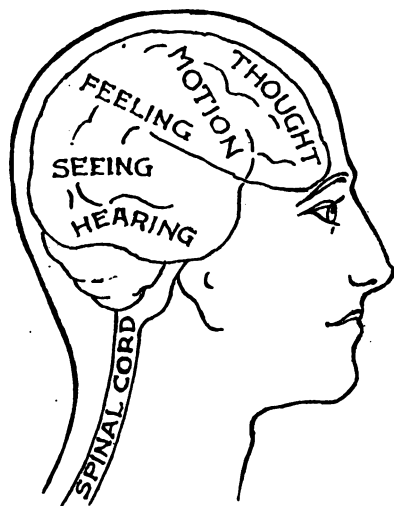


Diagram of the action of different parts of the brain.

receive and send out. This record is called the *memory*, and the messages which are recorded in it form a person's *knowledge*.

A person can look over the messages which he has stored in his memory. He can compare them with one another and in this way he can get new knowledge. This work of the mind is called *thinking*. Most of the work of thinking is done by the nerve cells which lie just behind the forehead.

Training the Mind. — The nerve cells of the cerebrum have many branching arms which extend to the nerve cells in other parts of the brain. By means of these branches a nerve cell knows what other cells are doing.

Brain cells and their branches grow by use, just as muscles grow by exercise. The brain cells of a baby are small, and their branches are few and short, but the branches grow in number and length as the child's mind grows. Your muscles and bones will stop growing when you are about twenty-five years old, but your brain cells may grow until you are about fifty years old, if you exercise your mind and train it.

When you stop studying and thinking, your brain cells stop growing. If you leave school when you are fifteen years old, and do not study or think hard after that age, your brain cells will also stop growing, and you will always have the mind of a fifteen-year-old child. But if you study, and read, and think, your brain cells and your mind will keep on growing for many years after your bones and muscles are full grown.

When you read a book about a bell or other object, you use the nerve cells which think. When you see a bell, or hear it, you also train the nerve cells which receive messages from the eyes and ears; and when you ring a bell, you train the nerve cells which send motor messages to your hands. Thus you may train your mind by seeing and hearing, and by working with your hands, as well as by reading.

Most mental training at school consists in teaching the thinking cells which lie just behind the forehead. But you will not be educated unless the cells by which you send motor messages, see, and hear, also receive training.

Laboratory work in school, and working in a carpenter shop, are as much a part of mind training as studying a book or listening to a speech. A boy who has been trained only from books at school or college has to start work in a low position in a shop or store in order to train that part of his brain which was not trained at school. But the boy who has trained his forehead cells to think will soon be able to train the rest of his brain.

Habits. — When you recall anything to memory, the cells of your brain try to do the same thing that they did when they formed that memory. When you think about a flower, the cells which receive messages of sight recall the messages which they have received about the color of the flower, and you can seem to see the flower again even when you close your eyes. When

you recall an act to memory, the cells which sent out the orders from the brain when the act was done want to send out the orders again when you think of the act.

After your brain cells have done an act a few times, they often try to repeat the act, whether you wish them to do so or not. We then say that you have a *habit* of doing that act. Every person forms habits in his work and play. Some persons form habits of always getting up early, eating properly, acting politely, and speaking pleasantly. All these are good habits.

Forming Good Habits. — No one starts life with any kind of habits, either good ones or bad ones. You form most of your habits while you are young. The good habits which you form will be as lasting as the bad ones.

Every one forms habits in his eating, dressing, speaking, thinking, sleeping, walking, and in doing all the other acts of everyday life. All these habits have an effect on the health of the body. For example, the things which a person eats, and the way in which he eats them, are among the principal things which affect health. Yet most grown persons eat in the way in which they formed habits of eating while they were young. Those whose eating habits are right seldom have indigestion or stomach troubles.

You will easily fall into bad habits if you are careless and do not think about your actions. Some boys and girls think they can do a forbidden thing a few times without forming a habit of doing it. There is danger

in doing any wrong or improper act, for by repeating the act you will do it more and more readily until you will do it without thinking. Do not begin to do a wrong or improper act at all.

You can overcome a bad habit if you put a right habit in its place. The cells of your brain will slowly forget a memory if you do not recall it to mind. If you wish to overcome a bad habit, watch yourself and do the act in the proper way. Your brain cells will then forget the wrong way of doing the act, and you will form a habit of acting properly.

Directing the Thoughts. — You can turn your thoughts to anything you wish, but your mind can do only one thing at a time, and do it well. When you try to do an arithmetic example, you forget your work if you look out of the window, or listen to a noise, or whisper to some one. If you have a hard example to do, keep your whole mind on your work until you finish it.

You can compel your mind to think of a single subject for many minutes or hours. A good scholar will not notice the sounds and sights around him, and will forget his feelings of hunger and thirst while he is getting his lessons. Every person who has a strong mind has the power to keep his whole thought on a single thing for hours at a time. One of the principal things which you learn at school is how to think without being disturbed by what goes on around you.

Nervousness. — If a person cannot keep his mind

on a single thing at a time, but is easily disturbed by what goes on around him, we say that he is *nervous*. Some persons suppose that what is called nervousness is a sign of a strong mind, because those who are nervous often take notice of slight feelings, sounds, and sights which most persons do not notice. No person can think well if he allows himself to be disturbed by what he feels, or hears, or sees. Nervousness is not a help, but it is a great hindrance to thinking.

Some children are nervous because they are not trained to behave, and to put their mind to their work. Others are nervous because they really have something the matter with their bodies. Those who are sick, or tired, or in pain, are nervous because they do not feel well. The sickness gives them about all the unpleasant feelings that they can stand, and if an unpleasant sight or sound is added to their feelings, they become cross and fretful. A child who has a stopped-up nose, and has to breathe through his mouth, is likely to be cross and fretful, for he always has an uncomfortable feeling, and any discomfort added to it makes more than the child can stand.

Other common causes of nervousness in children are sitting up late at night, indigestion, improper eating, adenoids, and foul air. These things are also causes of ill health. Doing the things which make the body healthy and strong will usually prevent or cure nervousness.

Joy of Health and Strength. — A person who is

healthy will have very few feelings which make him think about his body. He will be able to use his arms, and legs, and all the rest of his body as he would a machine which is in perfect order. Almost the only uncomfortable feelings that he will have will be hunger, thirst, weariness after work, and other feelings which tell him what his body needs. He will work hard for the pleasure of working, and will put forth his strength for the delight of using it. Children and young animals play until they are tired out, because the use of their strength is a joy to them.

A healthy grown person will enjoy life like a child. He will not notice the slight aches and pains which come while he works and plays, but he will enjoy trying his endurance and strength. Even his hunger and his tired feelings will not be unpleasant, for his eating, his rest, and his sleep will be among the greatest pleasures of the day.

Tired Nerve Cells. — When nerve cells work, they use up some of their own substance, as muscle cells do when they act. After a few hours of work they become small in size and unable to go on with their work. There is then a tired feeling like that which comes after muscular work. Nerve cells direct the actions of the muscles, and doing muscular work tires the brain as well as the muscles. Many of the tired feelings after exercise are due to tired nerve cells.

When a person thinks about a single thing day after day, the nerve cells which are in use do not get time to

rest. A scholar who thinks about his examinations for hours and days does not allow his brain cells to rest, but he comes to his test tired out. A person who worries wears out his brain cells by thinking about his troubles during every moment. Any one who sticks closely to only one kind of work without resting will finally ruin his health, for nerve cells need to rest and to store up food just as muscles need rest.

Nerve Rest. — A good form of nerve rest is a change of work, for it brings a different set of nerve cells into use, and allows the tired cells to rest. A boy who studies hard all day will get brain rest by playing baseball after school, for his thinking cells will rest while he uses the nerve cells with which he directs his muscles. A bookkeeper who sits at a desk all day may get brain rest by tending a garden, or driving, or taking photographs. A tired business man will rest his brain while he drives an automobile for an hour or two at the close of the day.

If a person has no liking for play or pleasure, his mind will always be thinking about his work, and the nerve cells with which he does his work will get no rest. It is a good thing for every person to learn to like some kind of play or pleasure, for during playtime the working cells of the brain will rest.

Play is also of great value because it often exercises those nerve cells which are not put to use during the hours of work. Many persons put their mind upon their business so closely that they do not know how to

look at a beautiful view, or how to listen to pleasant music, or how to saw a board. Learn to enjoy that kind of play which will train your mind as well as give you rest and pleasure.

Sleep. — The mind gets a complete rest during sleep, for then the nerve cells of the cerebrum seem to lose their connection with the rest of the body. But the spinal cord and the medulla act as perfectly while a person is asleep as while he is awake. The object of sleep is to allow the nerve cells of the cerebrum to repair their worn-out parts and take a new supply of food.

Every person must have sleep. He can go without food longer than he can go without sleep. One of the first signs of danger from overworking the mind is trouble in sleeping. This is because the nerve cells have formed such a habit of working every moment that they cannot stop working when the person lies down at night.

While the brain is at work, a large quantity of blood flows through it, but during sleep it contains only a little blood. One of the principal things which prevent sleep is too much blood in the brain. When you cannot fall asleep, you can often hear your pulse beat in the ear which lies on the pillow. Anything which will cause the blood to leave your brain will help you to fall asleep. Soaking your feet in hot water will cause the blood to flow to your feet and away from your brain. Eating a light lunch will cause the blood to flow to your stomach. Having some one rub your back will cause

the blood to flow to the muscles of your back. Listening to some one reading a dull book will keep you from thinking about your work, and the blood will then leave your brain, and you will feel drowsy. These are some simple things which will help you to fall asleep.

Insanity. — The brains of some persons do not act properly on account of injury or disease. A person who cannot take care of himself on account of brain injury or disease is called *insane*.

An insane man is usually able to do most brain acts in a proper way. His brain is like a printing press which is perfect except in one or two parts, and which will print a newspaper if the printer guides the paper through those imperfect parts. A man whose brain is unable to do any act in a proper way is called an *idiot*.

Most insane persons show their insanity only when they think of particular things. For example, some think they are kings wrongfully kept from their thrones. These insane persons are able to dress properly, to care for their bodies and rooms, and to read and understand the newspapers. They are dangerous because they are likely to injure other persons and destroy their property, just as real kings do when they go to war for their thrones.

Causes of Insanity. — There are over 40,000 insane persons in the hospitals of New York State. About one quarter of them are insane because of alcoholic drink or the use of opium. Another quarter are insane

as the result of an infectious disease which affects the whole body. Some were born with weak minds because their parents had weak minds.

Many persons with weak minds and diseased brains would not become insane if they did not overwork their brains. After constant worry or weeks of work upon a single object, the brain may be unable to change its thoughts or direct them to other objects. A person with such a brain is insane. Vacations, and play between the hours of work, would prevent many persons from becoming insane.

Care of the Insane. — If a person has an injured arm, the principal thing to do for it is to give it entire rest until it can grow strong again. The principal thing to do for an insane person is to prevent his brain from doing those acts which it cannot do properly. This can be done in the best way by taking the person away from his home and his work, and placing him in a hospital where new thoughts will fill his mind. Most insane persons improve, and many recover, within a few weeks or months after they enter a hospital.

Alcohol and the Brain. — One of the principal effects of alcohol on the body is to poison the nerve cells of the brain. This is what is meant when it is said that drink goes to the head. The most common form of the poisoning is drunkenness (p. 53).

When a person drinks, the first nerve cells to be poisoned are those with which thinking is done. One of the first signs that a man is getting drunk is that he

talks without thinking how his words sound. This poisoning begins soon after the alcohol is taken.

The next brain cells to be poisoned are those by which the muscles are moved. In this stage of drunkenness a person cannot walk straight or talk clearly.

The next brain cells to be poisoned are those by which messages are received through the senses. The drunken person then knows nothing, but lies as if in a deep sleep. The alcohol may also poison the cells in the lower part of the brain, and life is then in danger, for these cells control the breathing and the heart.

In olden times men used to have drinking contests to see who could drink the most. It was thought that the winner would be the coolest and most thoughtful person in times of accident or danger, for if alcohol did not upset his thoughts, it was supposed that nothing else would upset them. The alcohol often dulled his mind and thoughts, and the drinker would then perform daring acts. The reason why alcohol seemed to make men brave and cool was not that it helped them to think, but that it kept them from thinking clearly.

If alcohol really made men brave and thoughtful, it would be given to firemen when they go to dangerous fires. But one of the strictest rules in all fire departments is that the men shall not drink, for the kind of thoughtless daring produced by alcohol is dangerous both to the firemen themselves and to those whom they would try to save.

Effects of Light Drinking. — After the brain cells have been slightly injured over and over again, they cannot recover from the harm. Taking alcoholic liquors injures the mind, even though not enough alcohol is taken at any one time to produce drunkenness. The first signs that a drinker is harmed are usually shown by his carelessness in his work.

Drinkers lose their keenness of judgment, and often make mistakes in their work. If a drinker were the cashier of a bank, he would be likely to add columns of figures wrong. It would not be safe for a drinking man to run a locomotive engine, and the officers of a railroad will not employ a drinking man anywhere on the road if they know it. Many men lose good positions because of strong drink, and men who have great abilities often fail to secure good positions because they are drinkers.

Alcohol and Poverty. — The use of alcohol often makes men poor. They lose good positions on account of not being able to do their work well. They spend their money for drink instead of for food, and clothes, and houses.

A place where the effects of drinking may be seen is at an almshouse where poor persons who are too weak to work are supported at public expense. Over a quarter of all those who live in the poorhouses of the United States are there on account of drink.

Alcohol and Crime. — Another place where the effects of drinking may be seen is in a prison. From one

quarter to one half of all the persons in the jails and prisons of the United States are there because of drink. Many criminals take whisky to make themselves daring enough to commit their crimes. Some who would not be dishonest, if they were alone, are led to commit crimes by other criminals whom they meet in saloons. Others commit crimes because the drink takes away their thoughts and prevents them from seeing the badness of their acts. In some counties where the sale of strong drink has been forbidden the jails are almost empty.

Alcohol and Insanity. — A third place where the effects of steady drinking may be seen is in a hospital for the insane. Alcoholic drink is one of the most common of all the causes of insanity. Nearly a quarter of all insane persons have been ruined in mind by alcohol. Many insane persons are the children of drinking parents, and were born with weak minds because of their parents' drinking.

Cigarettes and the Mind. — The use of tobacco hinders the growth of the cells of the brain. Tobacco is a narcotic to the nerve cells of both the old and the young, but it is a far worse poison to young persons than to grown persons, because it prevents the nerve cells from growing. Very few boys who smoke cigarettes stand well in their classes at school. Nearly all boy criminals use cigarettes. Most of the idle boys who stand on street corners are cigarette smokers. When we see a boy smoking cigarettes, we think of

boys who are idle, or dull, or bad. A boy who smokes a cigarette, or who uses tobacco in any other form, is harmed as much as a grown man is harmed by alcohol.

QUESTIONS

Into what three parts is the brain divided?

What is the size and shape of the medulla?

What is the use of the medulla?

Why is the medulla sometimes called the seat of life?

Where is the cerebellum situated?

What is the use of the cerebellum?

Where is the cerebrum situated?

What is the size of the cerebrum?

Where is the gray matter of the cerebrum?

Of what use are the folds on the surface of the cerebrum?

What part of the brain does the conscious work of the mind?

What are the three principal kinds of work which are done by the nerve cells of the cerebrum?

In what part of the cerebrum are the nerve cells with which a person feels, sees, and hears?

In what part of the cerebrum are the nerve cells which send orders to the voluntary muscles?

What is memory?

What takes place in the brain when a person thinks?

In what part of the cerebrum are the nerve cells with which thinking is done?

What happens to nerve cells when the mind is trained?

What is a *habit*?

How are good habits formed?

How may bad habits be overcome?

What is nervousness?

What are some of the causes of nervousness?

How do tired nerve cells differ in appearance from rested cells?

How does a change of work help to rest nerve cells?

What makes nerve cells tired during muscular exercise?

Of what value is play to a business man?

What is the use of sleep?

What are some of the reasons why a person cannot fall asleep when he lies down at night?

What are some of the things which will help a person to fall asleep?

What parts of the brain are poisoned when a person is made drunk by alcohol?

What effect does light drinking have on a person's mind?

What effect does drinking have on a person's getting employment?

What effect does drinking have on a person's power to earn money?

What effect does drinking have in causing crime?

What effect does drinking have in producing insanity?

What effect does tobacco have on the brain cells of young persons?

What effect do cigarettes have on the minds of boys who smoke?

CHAPTER XXXI

THE SENSES

Use of the Senses. — The principal nerve messages of which a person is conscious are those which are received through the senses (p. 311). They consist of messages of touch, smell, taste, hearing, and sight. Their principal uses are to give the mind a knowledge of what goes on outside of the body, and to tell a person about his safety and comfort.

Touch. — The sense of touch is produced by the pressure of objects upon nerves that lie just beneath the epidermis of the skin (p. 163). If the epidermis is removed, anything that touches the skin produces a feeling of pain or smarting.

The sense of touch gives the mind a knowledge of the size, shape, hardness, smoothness, weight, and warmth of objects which touch the skin. The parts of the body in which the sense of touch is the keenest are the ends of the fingers and the tip of the tongue.

One way of testing the sense of touch is to prick the skin with the sharp points of a pair of compasses. The skin of the back will seem to feel only a single point if the tips of the compasses are separated two inches. The ends of the fingers can feel that the points are

separated if the points are only one eighth of an inch apart.

Weight. — A person judges the weight of an object in two ways: first, by the feeling of touch and pressure which the object gives when he holds it in his hand ; and second, by the feeling which he has in his muscles when he lifts it.

False Messages. — The nerves of feeling go from the skin to the spinal cord, and then to the brain. If a nerve is wounded anywhere in its length, the feeling seems to be at its outer end, and not at the place where it is hurt. What is called the *funny bone* is a nerve which lies just above the inner side of the tip of the elbow. If it is pinched at the elbow, there is a feeling of pricking and smarting in the little finger where the nerve starts.

When sitting with the legs hanging down from the edge of a chair, the foot often tingles and feels heavy and “asleep,” because the nerves which go from the foot to the spinal cord are pinched at the knee. At the beginning of hip-joint disease the pain is usually felt in the knee, and in appendicitis the pain often seems to be over all the lower part of the body. The part in which a pain is felt is not always the part which is out of order.

Training the Sense of Touch. — You can train the sense of touch by use. Surgeons train their finger tips in the examination of parts which lie deep in the body. Blind persons learn to read by passing their

finger tips over raised letters. When you train your sense of touch, you train the nerves under the skin to receive slight impressions. You also train the cells of your brain to recognize slight differences in the messages which they receive. Training the sense of touch is excellent mental training.

Smell. — Tiny bits of matter are always passing into the air from everything which has an odor or smell. When these bits of matter touch the nerves of the nose, they give rise to a message which the brain receives as a smell. By means of the sense of smell a person can judge of the purity of food and air. Dogs, and some other lower animals which have a keen sense of smell, depend upon it in the same way that persons depend upon the sense of sight.

Taste. — When a substance which has a taste is taken into the mouth, some of it dissolves in the saliva and soaks through the epidermis. When it touches the nerves of the tongue, it gives rise to a message which the brain cells receive as a taste. The sense of taste enables a person to judge the purity and wholesomeness of food. The taste of food also has a great effect on the flow of gastric juice, and on the digestion of food (p. 229).

A person judges the tastes of sweetness and sourness by means of the nerves in the front part of the tongue. He judges bitterness and saltiness by means of the nerves in the back part of the tongue. He judges the taste of spices largely by means of particles which rise to the

nose and there produce an odor. A person who has a cold in the nose loses a part of his sense of taste, because of the hindrance to his sense of smell.

Hearing. — One way in which a person learns about objects which do not touch the body is by means of rapid air waves which are set in motion by the objects when they stir. These air waves, striking the nerves of the ear, produce the messages which the brain receives as sounds. An object is heard only when it moves, for if it does not move, it does not produce waves in the air. Loud sounds are caused by strong air waves which are sometimes felt with the nerves of the skin, but the only waves which are heard are those which strike the nerves of the ears.

The Ears. — The ear consists of three parts, called the outer ear, the middle ear, and the inner ear.

The outer ear consists of two parts: first, the shell,



Photograph of the bones of a human ear. *a*, eardrum; *b*, bones of the middle ear; *c*, inner ear.

which is usually called the ear; and second, a tube which extends from the shell of the ear about an inch into the side of the head. The bottom of this tube is closed by a thin sheet of flesh called the *eardrum*.

A space called the middle ear is hollowed out of hard bone behind the eardrum. The middle ear is

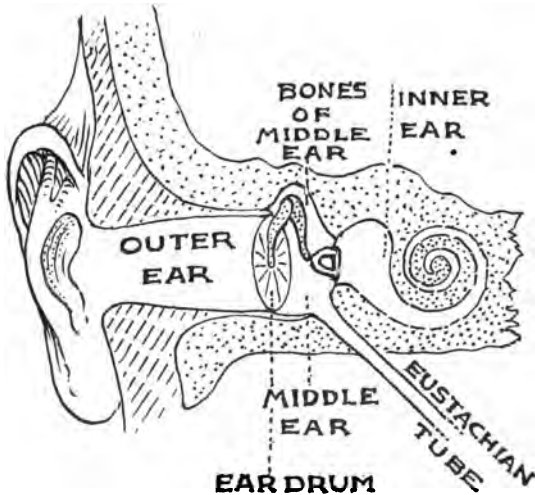


Diagram of the ear.

filled with air, and contains a chain of three small bones which extend across it from the eardrum to a smaller drumhead on the opposite side.

A small space called the inner ear is hollowed out of the hard bone behind the inner drumhead. The inner ear is shaped like a snail shell and is filled with a liquid in which the nerves of hearing lie.

How a Sound is Heard. — Air waves strike the eardrum, and cause it to move back and forth. This moves the bones of the middle ear, and they produce waves in the liquid of the inner ear which strike the nerves of hearing. The nerves carry a message of the motion to the brain, and the brain cells receive the message as a sound.

Deafness. — If a person cannot hear well, we say that he is *deaf*. Deafness is nearly always caused by some trouble in the middle ear.

A tube called the *Eustachian tube* extends from the middle ear to the throat. If you hold your nostrils closed, and try to blow hard, you will force air into the middle ear. You will then feel a buzzing in your ear, and will not be able to hear well, for the pressure of the air will keep the eardrum from moving freely. When you swallow, you open the tube and let the air out of the middle ear, and you can then hear well again.

Most deafness is caused by throat trouble which stops up the Eustachian tube. For this reason adenoids are often the cause of deafness. Most children who are deaf have adenoids, and removing the adenoids will nearly always help their hearing (p. 128).

Running Ears. — Sometimes a soreness and swelling in the throat extend up the Eustachian tube into the ear. The ear then becomes filled with a thick liquid, like that which is coughed from the throat. This liquid presses upon the eardrum and causes an earache. If

the drum bursts, the pain will stop as soon as the matter runs out. But some matter will often keep on running from the ear for days and weeks afterward.

A child who has earache and running ears is nearly always deaf. Most of these children may be made well, and their deafness cured, by a skillful physician.

Testing the Hearing. — Many children seem to be dull and careless at school because they are slightly deaf and do not hear what is said to them. In many schools the hearing of every scholar is regularly tested.

A good way to test a person's hearing is to stand about ten feet away from him and whisper numbers for him to repeat. In this way you can find out how loud a sound he can understand. Test each ear separately while the other ear is closed.

A person with good hearing will be able to understand a loud whisper in a quiet room about twenty-five feet away from his ear. If he can understand a loud whisper no farther away than five feet, his hearing is only one fifth as good as it should be. It is a good plan for a person with good hearing to stand beside the one whom you are testing, so as to compare the hearing of the two.

Training the Hearing. — Most sounds are made up of many separate sounds. The sound of the music made by a singing class is made by a number of persons, and a trained musician can pick out the sound of each separate voice. The same sounds fall upon the ears of all who listen to the music, but the trained person

will notice differences between sounds which seem alike to untrained persons. Training the ears is really training the brain to notice slight differences in the messages which the ears send to the brain.

Injuries to the Ears. — The middle ear and the inner ear are hollow spaces deep in a hard bone of the skull, and are seldom injured except by blows which injure the whole skull. Almost the only way in which an ear is likely to be injured is by thrusting something against the eardrum. Picking the ears in a careless way, or putting things into the outer ear in fun, may injure the eardrum. Slapping or boxing the ears may also injure the eardrum by producing a sudden pressure of air upon it.

Earwax. — A brown wax is formed by the skin which lines the outer half of the tube of the outer ear. The use of the wax is to protect the lining of the outer ear. The epithelium of the skin grows outward and carries the wax with it, and there is seldom need to pick the wax from the ears. If it should collect, it may be removed safely by means of the loop of a fine wire hairpin.

QUESTIONS

What are the *senses*?

Of what use are the senses?

In what part of the body is the sense of touch produced?

In what part of the body is the sense of touch the keenest?

How can you test the sense of touch?

What sense do blind persons use when they read?

How do you judge the weight of an object?

Explain the unpleasant feeling which you have in your little finger when you pinch your funny bone.

Explain the feeling which you have in your foot when it is asleep.

How is the sense of smell produced?

Of what use is the sense of smell?

How is the sense of taste produced?

Of what use is the sense of taste?

What kinds of taste do you judge with the front part of your tongue?

What kinds of taste do you judge with the back part of your tongue?

How does the sense of smell help you to judge the taste of an object?

How does a bell or other object produce a sound?

Of what does the outer ear consist?

What are the principal parts of the middle ear?

What are the principal parts of the inner ear?

How does sound travel from the outer ear to the nerves of hearing?

What is the Eustachian tube?

How does throat trouble produce deafness?

How do adenoids produce earache?

How can you test the hearing of a person?

How can you train the hearing?

How does brain training help the hearing?

How may slapping the ears injure the hearing?

How may earwax be removed from the ears with safety?

CHAPTER XXXII

THE EYE

Importance of Sight. — The principal way in which we learn about an object which is beyond our reach is by means of light which comes from it to our eyes. If our sight were suddenly taken away, few of us could carry on our daily work. We would prefer to lose almost any other part of the body rather than an eye.

The Eyeball. — The framework of the eye is a thick and tough shell called the *eyeball*. The eyeball is shaped like a hollow globe, and is filled with a clear liquid. It is white except its front part which is clear, like glass, and is called the *cornea*.

The Iris. — The eyeball has a dark-colored lining, called the *choroid coat*, which is about as thick as writing paper. The front part of this lining hangs like a curtain behind the cornea, and is called the *iris*. The color of the iris is usually some shade of blue or brown. It shows through the cornea, and gives the eye its blue or brown color.

The Pupil. — In the center of the iris there is a round hole, called the *pupil*, through which light enters the eye. The pupil appears black because the inside of the eye is dark in color. The iris contains muscles

which regulate the size of the pupil. A strong light causes the muscles of the iris to contract and make the pupil small in order to shut out some of the light. When the light is dim, the muscles relax and the pupil becomes large so as to admit as much light as possible. The pupil of a cat's eye is only a narrow slit in the daylight, but at night it is a large, round hole which admits much more light than the pupil of a person's eye. For this reason a cat can see at night better than a person.

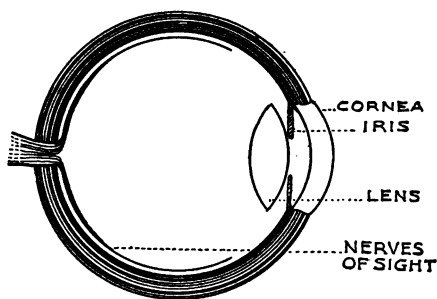


Diagram of the eye.

The Lens. — A rounded piece of tough flesh, called the *lens*, lies just behind the pupil. It is as clear as glass, and its front and back faces are curved like the faces of a small magnifying glass. Its use is to bend rays of light in such a way that they come together upon the back of the eyeball, and there form a picture of objects which are in front of the eye.

The Retina. — A large nerve called the *optic* nerve enters the back part of the eyeball and spreads over the choroid coat. This coating of nerves is called the *retina*. When light falls upon the retina, its nerves carry a message of sight to the brain.

The Eye like a Camera. — An eye is like a pho-

tographer's camera. The eyeball is like the camera box. The choroid coat is like the black paint with which the inside of the camera is coated. The cornea and the lens are like a double lens in the camera. The retina is like the plate on which the picture is formed.

Focusing the Eye. — When a photographer takes a picture, he moves the lens back and forth until the image is distinct upon the back part of the camera. If the image of a distant object is distinct, the image of an object near the camera will be blurred. Adjusting a camera to make a distinct image of an object is called *focusing*.

The eye is naturally focused to form a distinct image of an object which is over twenty feet away. When a person looks at an object which is nearer than twenty feet, muscles inside the eyeball make the lens more curving or bulging, in order to form a distinct image upon the retina.

Reading often tires the eyes, because the muscles of the eyes have to act upon the lens in order to form clear images of the print. When your eyes become tired from study, you may rest them by looking at the view from a window, for the muscles which focus your eyes are at rest while you look at distant objects.

Blurred Sight. — A person who has good sight can focus his eyes to see an object which is only six inches away. Some persons can see distant objects clearly, but their eye muscles are unable to make the lens curving enough to see objects close by. These persons are

called *farsighted*. The lenses of their eyes are not sufficiently curved. Most persons become farsighted after they pass the age of forty years.

Some persons cannot see distant objects clearly, but have good sight for objects which are held only a few inches from their eyes. These persons are called *nearsighted*. The lenses of their eyes are too curving.

Sometimes the lens or the cornea is not perfectly curved, but is irregular in shape. Objects then appear blurred. This trouble is called *astigmatism*.

Use of Spectacles. — Farsightedness, nearsightedness, and astigmatism may all be helped by the use of spectacles, for the roundness of the glasses will correct the faults in the roundness of the lenses of the eyes. Proper glasses will not harm the eyes in any way, but they will strengthen the eyes, and will keep the sight from failing. Going without glasses when they are needed is often a cause of weak eyes and headaches.

Spectacles that are held in place by bows over the ears are more comfortable than eyeglasses that are held in place by springs fastened to the nose. If children wear eyeglasses, the pressure of the springs may hinder the growth of the bones of their noses.

No one can see well through dirty glasses. If you have to wear glasses, clean them with a soft, clean handkerchief when they become dusty or soiled.

If the spectacles are set crooked on the nose, the eyes will ache from trying to look through them. If they will not stay in place squarely in front of the

eyes, bend their frames or bows so that they will fit the eyes.

Cross-eyed Sight. — The eyeball may be turned or rolled in every direction by means of six muscles. The eye must be turned directly toward an object in order to see it clearly. If a person's two eyes are not turned equally toward an object, two images of the object will be seen. The person is then said to see double, and to be *cross-eyed*.

Some persons have double sight only when their eyes are tired. This is because their muscles are able to turn their eyes properly until they become tired. Slight forms of double sight are often the cause of severe headaches. Cross-eyed sight and the headaches resulting from it, may be relieved by a good oculist.

Signs of Poor Sight. — Many persons have poor sight and do not know it. Many children seem to be dull at school, because they cannot see well. Many children are born with poor sight, and no one finds it out until the children go to school.

One of the principal signs of poor sight is a headache which comes on after using the eyes. The cause of the headache is a pain in the muscles of the eyes.

Another sign of poor sight is a blurring of the sight after the eyes are used for some time. The cause of the blurring is the tiredness of the eye muscles from the constant strain of focusing or turning the eyes.

Testing the Sight. — Cards for testing the sight may be obtained at most jewelry stores. They bear large

letters of various sizes clearly printed on cardboard. Test a person's eyes by placing one of the cards about twenty feet away, and have him read as many of the letters as he can. The following table gives the distances at which a person with good sight should be able to read letters of various sizes.

Height of Letter.	Distance at which it may be Read.
$3\frac{1}{2}$ inches	200 feet
$1\frac{3}{4}$ inches	100 feet
$1\frac{1}{4}$ inches	70 feet
$\frac{7}{8}$ inch	50 feet
$\frac{3}{4}$ inch	40 feet
$\frac{1}{2}$ inch	30 feet
$\frac{3}{8}$ inch	20 feet

A person's sight may be recorded in the form of a fraction in which the numerator is the distance of the person from the card, and the denominator is the distance at which the smallest letters which he reads should be read by a person with good sight. For example: If a person stands 20 feet from a card, and the smallest letters which he can read are $\frac{3}{4}$ inch high, he sees only $\frac{20}{40}$, or $\frac{1}{2}$ as well as a person who has good sight.

If your sight is not good, go to an oculist and let him test your sight and fit you with glasses. Most persons who have poor sight are able to see well when they wear the right kind of spectacles.

How the Sight is Injured. — Many children are born with an eye weakness which becomes worse after strain-

ing the eyes and using them improperly. The most common causes of harming the eyes are a wrong light, and a wrong position in reading or working.

Wrong Lighting. — A bright light shining into the eyes causes their muscles to contract so as to shut out the light. The muscles constantly pulling upon the eyeballs may press them out of shape and cause blurred sight.

Reading in a dim light tires the muscles of the eyes, for when the sight is not good, the muscles keep trying to focus the lenses. A light is of the proper strength when it is agreeable to your eyes.

The best position for the light is at your left side, for it then does not shine into your eyes, and your right hand does not shade your work.

Improper Position in Reading. — When you look directly forward, the muscles which move your eyes are at rest. When you turn your eyes up, or down, or sidewise, the muscles flatten the eyeball as they pull upon it, and prevent you from seeing distinctly. When you read, place your book squarely in front of your face in order that your eye muscles may have as little work to do as possible. When you study at a table, have the top of your book raised, in order that the pages may lie squarely before your eyes while you sit upright.

Reading while lying down tires your eyes, for you then have to turn your eyes downward toward your feet. When you read on a railroad train, your book

shakes, and your muscles soon become tired in keeping your eyes turned toward the page.

Injuries to the Eye. — The eye is set deep in a bony socket which protects it from blows. It lies upon a bed of fat which acts like a spring and allows it to slip about when it is jarred or struck. The outer shell of the eyeball is as thick and tough as sole leather, and can scarcely be cut with a sharp knife. An eye is seldom injured by accident except by shot or by sharp instruments which strike it directly in front.

Sometimes the skin around the eye is made purple or black by blows over the eye. The color is seldom in the eye itself, but is in the bruised skin around the eye.

Dirt in the Eye. — The eye is covered with two movable lids which protect it from dust and slight injuries. The surface of the eye is moistened with a fluid, called *tears*, which is produced by a gland lying just above the eyeball.

The eye is very tender, and becomes painful when there is a speck of hard dirt between the lids and the eyeball. If you have a bit of dirt under an eyelid, do not rub the eye, for the rubbing makes the dirt scratch the eye. Grasp the eyelashes, and hold the lid away from your eyeball for a moment. The tears may then wash the dirt away. If the dirt does not come away, let a friend lift the eyelid and brush the dirt away with the corner of a clean handkerchief.

Sore Eyes. — The most common cause of sore eyes is disease germs growing under the eyelids and on the

eyeball. The germs make the eyes red, and cause them to smart and to ache. Many kinds of eye diseases are infectious, and are caught from other persons who have sore eyes.

Do not use a towel or handkerchief which has been soiled by any one with sore eyes. If you have sore eyes, use your own towels and handkerchiefs, and boil them before they are washed. You can help to cure sore eyes by washing them often with warm water so as to remove the germs.

The eyes of babies are often injured by allowing house flies to crawl over them. When a baby is asleep, drive the flies from the room, or cover its face with mosquito netting in order to prevent flies from crawling over its face.

One form of sore eyes is called *granulated lids*, or *trachoma*. It is very infectious, and is becoming common in some places. If it is not properly treated, it becomes worse and worse, and often destroys the sight. But it may readily be cured by a doctor.

Training the Eye. — When you look at an object, images of everything in front of your eyes are formed on their retinas, but the brain takes notice of only the images which you wish to see. For example, if you look at a bird in a tree, images of the bird, the tree, and the sky are all formed in your eyes, but your brain takes notice of the image of the bird only.

When you look carefully at an object, the thing which you wish to see is often the dimmest and most blurred

part of the object. You can train your brain to notice and recognize dim and blurred images that scarcely make an impression on the eye at all. For example, a sailor, seeing a dim speck miles away on the water, can tell whether or not it is a ship, and what kind of vessel it is. Training the eyes is really brain training. Any person who has fair sight can train his brain to see things which an untrained brain will not notice at all.

Tobacco and the Eyes. — Tobacco sometimes injures the nerve of the eye, and produces blindness. Smoking is more likely to injure the eyes than the use of tobacco in any other form. The blindness usually passes off when the tobacco is stopped.

QUESTIONS

Describe the eyeball, and name its principal parts.

Of what use is the iris?

Of what use is the lens?

In what respect is the eye like a photographer's camera?

How is the eye focused?

What is *farsightedness*?

What is *nearsightedness*?

What is *astigmatism*?

How do spectacles help the sight?

Why are spectacles with bows more healthful than eyeglasses that pinch the nose?

What is the cause of double sight?

What are some of the signs of poor sight?

How does poor sight cause a headache?

How can you test the sight?

How does a wrong light injure the eyes?

How does reading on a railroad train tire the eyes?

What position of the body and arrangement of the light are the most comfortable for the eyes?

How is the eye protected from injury?

Of what use are tears?

Why is it harmful to rub an eye when there is a speck of dirt in it?

How can you remove dirt from under an eyelid?

Name some ways in which soreness of the eyes may be spread from one person to another.

What is *trachoma*?

How can you train your eyes to see faint and indistinct objects?

What effect does tobacco have upon the sight?

CHAPTER XXXIII

THE VOICE

Vocal Cords. — The sound of the voice is made in a box, called the *larynx*, which forms the uppermost part of the windpipe. The front upper corner of this

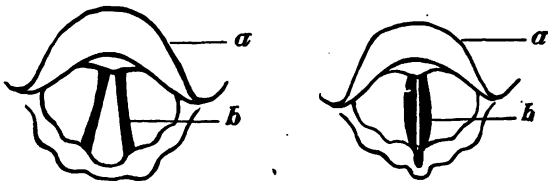


Diagram of the vocal cords. *a*, epiglottis; *b*, vocal cords.

box forms the lump called the Adam's Apple, that may be felt in the front of the neck just below the chin.

Two white bands of flesh called *vocal cords* are tightly stretched backward across the top of the larynx. When the cords are tightened and brought close together, and air is forced between them, they tremble back and forth and make a sound in the same way that blowing through a tin horn produces a noise. The sound made by the vocal cords alone is unpleasant and squeaking, but it is increased in power and made pleasant by means of the nose, mouth, tongue, and teeth.

Speech. — When a sound is made in the throat, the lips, teeth, and tongue may change the air current in such a way that the sound forms letters and words. You form the letter *P* by starting with your lips closed, and suddenly forcing them open with a blast of air which passes through the vocal cords. You form the letter *M* by starting a sound with the lips open, and suddenly closing them. When you whisper, you do not use the vocal cords at all, but make use of the sound produced by blowing air through the lips.

Some boys and girls who do not pronounce their words plainly suppose there is something wrong with their lips or tongue. This is almost never so. The reason why they do not talk distinctly is because they have not learned to move their lips and tongue correctly. They can learn to speak distinctly if they will notice the correct positions of the tongue and lips in pronouncing difficult words, and will then practice speaking the words clearly.

Hearing and Speech. — A person who cannot talk is said to be *dumb*. A baby learns to talk by hearing the voices of other persons. The reason why dumb persons cannot talk is that they are deaf and do not know what words sound like. There is seldom anything the matter with their noses and throats, and they learn to talk when they are shown how to place their lips and tongues in order to form words. Children who are totally deaf soon learn to talk when they are sent to a school for the deaf and dumb.

A Pleasing Tone of Voice. — You like to hear some persons talk, because their words sound like music. The voices of others are loud, or shrill, or whining, or have some other unpleasant tone that makes you feel uncomfortable. A voice with an unpleasant tone keeps you from resting and increases your discomfort when you are sick. The tone of voice with which you usually speak will have a great effect upon the health and comfort of others.

You can form a habit of speaking with a pleasing tone if you try to do so. To speak always in a pleasant and distinct tone of voice is one of the most pleasing habits that you can form.

Exercising the Voice. — The sound of the voice is formed by means of muscles. If boys and girls do not use their voice muscles, they will grow up with weak voices, and will be unable to sing or speak with strong voices, or for many minutes at a time.

You can make your voice muscles strong by exercising them, just as you make the muscles of your arm strong by use. A good form of voice exercise is to read aloud at home in the evening.

If you use your voice muscles until they are overtired, you will make them weak, just as overworking your arm muscles will make them weak. Some of the ways in which boys and girls are likely to injure their voice muscles is by loud shouting, singing for a long time, and cheering at games.

The voice of a young boy sounds like a girl's voice,

but at about the age of fifteen his larynx suddenly grows faster than his body. This growth produces a change in his voice by which it becomes low-pitched and deep like a man's voice. While this change is taking place, the voice muscles may be strained more easily than at any other time.

QUESTIONS

- Where is the sound of the voice made?
- Describe the larynx.
- How do the vocal cords produce sound?
- What organs do you use when you pronounce letters and words?
- How do you form the letter *P*?
- How is the letter *M* formed?
- How can you improve the distinctness of your speech?
- What is the cause of dumbness?
- How may a deaf and dumb person be taught to speak?
- Name some ways in which the tone of the voice may affect a person's health.
- How can you exercise the voice?
- Name some ways in which the voice may be strained.
- What is the change of voice in boys?

CHAPTER XXXIV

PUBLIC HEALTH AGENCIES

Schools. — Men of olden times lived in a natural way like wild animals, and were as healthy as the wild animals. When men began to build houses and to live in cities, they shut out the life-giving light and air, and polluted their supplies of food and water. They then began to suffer from epidemics and pestilences that were almost unknown while they lived in a wild state. One object of teaching hygiene in schools is to teach pupils how they can live in modern houses and in crowded cities and still preserve all that was healthful in the natural way of living as wild animals live. It is the duty of the government to compel each child to learn how to live a healthful life.

Street Cleaning. — The streets of a town or city belong to the people, and are free for everybody to use. It is the duty of the government to keep them clean and safe for those who use them. The work of a street cleaning department of a city has an important effect on the health of the people of the city.

The dust and dirt of city streets usually contain disease germs which come from sick persons and sick animals. There is often a great increase in the number

of persons sick with colds and sore throats in the spring when warm weather sets free the disease germs which snow and ice have bound fast to the streets during the winter. One of the duties of the street cleaning department of a city is to sweep and clean the streets. The department also clears away the snow and ice, and makes paths through the snowy streets. It also sprinkles the streets on dry days in order to prevent dust and disease germs from blowing into the faces and homes of the people. New York employs about 3000 street cleaners who clean about 1500 miles of street every day.

City Rubbish. — The people of cities have no large back yards or waste lands on which they can dump their ashes and rubbish. If house wastes are left in piles, they decay and become the breeding places for disease germs, flies, and rats. The street cleaning department collects the waste rubbish and garbage, and carts them away. This is expensive, but many cities sort over the rubbish and make use of a large part of it. Ashes are used to fill in low land. Papers and everything else that will burn are fed to the boilers of steam engines. Rags are sold for paper making, bones for fertilizer, and tin cans for solder. Waste meat and table leavings are boiled and pressed in order to extract their fat, and the refuse is sold for fertilizer. About 1500 drivers of rubbish carts are employed by the street cleaning department of New York.

Water Supply. — Every person in a city must use

water, but it is often impossible to obtain an abundant supply of pure water without going a long distance away. It is the duty of every city government to provide pure water for every person in the city. Most cities build waterworks at public expense, and sell the water to the people at low rates.

Sewage Disposal. — The work of the water department of a city is only half done when it has brought pure water into a town, for the used-up water is dirty and impure, and full of disease germs, and must be removed. It is proper for the government to remove sewage at public expense, for every person helps to make the waste water impure and dangerous to health.

The old-fashioned way of getting rid of sewage was to empty it into the nearest stream or body of water. This method endangers the health of other people who use the water in any way. It is the duty of every city to erect a sewage disposal plant, in order that its sewage will not make the people of other places sick (p. 179).

Fire Department. — Fires are the cause of hundreds of deaths each year. They destroy millions of dollars' worth of property, and produce untold suffering. They often endanger the safety of a whole city. A fire department is a necessity in every town and city. Firemen often have to go into places which are far more dangerous than a field of battle, and every day they do deeds which are as heroic as any which a soldier has to perform.

The duty of a fire department is to prevent fires as well as to put them out after they have started. Most cities have laws against storing rubbish in cellars and back yards where there is danger of fires spreading.



A hose cart going to a fire in New York.

There are also laws against storing gasoline, gunpowder, and other explosives in buildings where people live and work, and against starting fires and burning rubbish near buildings. It is the

duty of the officers of the fire department to enforce the fire laws. They also see that the aisles of public meeting places are not obstructed, and that fire escapes are in good order and ready for instant use.

Carelessness with Matches. — More fires are due to carelessness in handling matches than to any other cause. Smokers often carry matches loose in their pockets, and throw burning matches and cigar ends on the floor and into waste baskets. Boys and girls often start fires by playing with matches. There are about five times as many fires in the United States as in Germany. The principal reason why this is so is because the people of Germany are more careful with matches and fire than the people of the United States.

Parks and Playgrounds. — Boys and girls cannot be healthy and happy without play. In crowded cities there are few places in which to play out of doors, except in the streets. It is the duty of the government to provide open parks and playgrounds where children may run and play games away from the dust, disease germs, and other dangers of the streets.

Playgrounds improve the behavior of boys and girls as well as their health. Whenever a new playground is opened in New York there is always a lessening in the amount of mischief and crime among the boys who live near it, for they expend their strength in play instead of in troubling other people.

Hospitals. — Every city and village has many poor people who have no place where they can receive proper care when they are sick. Many people, both rich and poor, have no houses or rooms in which they may have surgical operations performed, or in which they may be isolated or quarantined when they have contagious diseases. Public hospitals are provided where they can receive doctoring and nursing and be restored to health and strength. New York has over a hundred public hospitals where the poor may stay and be treated. There are also about sixty-five public dispensaries for the treatment of poor people who are able to walk about.

Tuberculosis Hospitals. — More people are sick with tuberculosis than with any other disease, but there are fewer hospitals for the treatment of tuberculo-

sis than for the treatment of other diseases. The prevention and treatment of tuberculosis consist largely in educating the sick persons themselves in the way to eat, to breathe, to sleep, and to dispose of their sputum. This may best be done in a hospital for tuberculosis cases only. When the governments of cities, counties, and states erect enough hospitals for the treatment of those who have tuberculosis, and also compel all those who have tuberculosis to learn how to prevent its spread to others, the disease may be wiped out as completely as smallpox has been.

Churches. — In olden times the priests of the churches and temples were almost the only teachers of the young, and healers of the sick. One great work of the church is still to assist in the education of the young, to comfort the sick, and to promote healthfulness among all people. Churches are found in every city and village. They assist the poor and the needy, and are among the greatest of all institutions for promoting the health and peace of the country.

Charitable Societies. — Many helpless children and unfortunate old persons need help in every town and city. The government provides homes for orphans, for aged people, and for the insane. There are also a great number of societies for the help of the needy, such as societies for the prevention of cruelty to children, for teaching the blind, for promoting temperance, and for the help of crippled children. These societies do an immense amount of good in promoting health.

Health of Mind and Body. — Men of olden times thought that the body was opposed to the mind. They used to starve themselves, and to torture their flesh in trying to weaken their bodies so as to free their minds and spirits. Now we know that the only persons whose minds are entirely free are those whose bodies are in such perfect health that their minds are not disturbed by any unpleasant bodily feelings. The first thing to do in helping the mind of any troubled person is to help him to make his body comfortable and healthy. One of the greatest of all the duties of a government is to provide the means by which each person may preserve a healthy mind in a healthy body.

QUESTIONS

Give some reasons why the government should compel every school child to study hygiene.

Give some reasons why officers of a city should sprinkle and clean the streets at public expense.

Give some reasons why the city should remove garbage and rubbish at public expense.

Why should the water supply of a town be under the control of the government?

Why should the sewage disposal of a town be at public expense?

How does the fire department help to promote the health of a town?

Of what use are parks and playgrounds in promoting the health of the people of a town?

Give some reasons why the government should build hospitals for the treatment of tuberculosis.

How do churches promote good health among people?

How do charitable societies promote good health?

How does good bodily health promote good health of the mind?

GLOSSARY

Absorbent cotton, cotton prepared for dressing wounds.

Absorption, taking food from the intestine by the blood.

Acetic acid, the sour substance in vinegar.

Adenoids, soft growths of flesh in the back part of the throat and behind the nose.

Adulteration, mixing a cheap substance with a valuable one in order that the mixture may closely imitate the valuable substance.

Albumin, another name for protein.

Alcohol, a colorless liquid used in manufacturing. It is also found in beer, wine, whisky, and other strong drinks.

Alga, one of the simplest kinds of plants.

Anatomy, the study of the structure of the body.

Antiseptic, a substance that will kill bacteria and disease germs.

Antitoxin, a substance that will destroy the poisons of disease germs in the body. Antitoxins for diphtheria and lock-jaw are in common use.

Aorta, the artery next to the heart.

Artery, a blood tube that carries blood from the heart.

Artificial respiration, making air pass into and out of the lungs in imitation of natural breathing.

Assimilation, making food into a part of the body, or putting food to use in the body.

Astigmatism, blurred sight due to an unevenness of the cornea.

Auricles, the two thin-walled cavities on the upper end of the heart.

Bacteria, the smallest known plants. Some cause decay, and others produce diseases.

Bandage, a dressing wrapped around a wounded part.

Biceps, the muscle that bends the elbow.

Board of Health, a body of officers who have charge of matters pertaining to public health.

Bronchi, the air tubes of the lungs.

Caffeine, the stimulating substance in coffee and tea.

Calorie, the quantity of heat that will raise the temperature of four pounds of water very nearly one degree Fahrenheit.

Capillaries, the microscopic blood tubes that connect the arteries and the veins.

Carbohydrates, starches and sugars.

Carbolic acid, a poisonous liquid used to kill disease germs.

Carbon, a substance found in every living thing; charcoal.

Carbon dioxide, a gas formed by burning or oxidizing carbon.

Cartilage, tough flesh resembling softened bone; gristle.

Catarrh, a kind of throat trouble that resembles a constant cold. It is usually caused by adenoids.

Cells, the smallest bits of living matter that are capable of growing when separated from the body.

Cerebellum, the rounded part of the brain under the hinder part of the cerebrum.

Cerebrum, the large rounded mass forming the upper part of the brain.

Certified milk, pure, clean milk produced under the oversight of a board of doctors.

Cesspool, an underground tank for receiving sewage.

Choroid coat, the dark coat on the inside of the eyeball.

Cilia, the velvet-like projections on the lining of the bronchi.

Circulation, the flow of blood through the body.

Coagulation, the process of a liquid becoming jelly-like; clotting.

Cold, any mild form of infectious disease.

Cold storage, preserving articles in rooms which are kept nearly freezing cold.

Congest, to fill with more blood than usual.

Connective tissue, the tough fibers that hold cells in place.

Consumption, a lung disease caused by the bacteria of tuberculosis.

Convulsion, a contraction of all of the muscles of the body, due to sickness.

Cornea, the clear window in the front of the eyeball.

Corpuscles, the bodies that float in the liquid part of the blood.

Culture, an artificial growth of bacteria in a bottle or tube.
Cultures are usually made to determine their kinds.

Decay, the process by which matter once living slowly goes to pieces and is finally returned to the soil and air.

Diaphragm, the sheet of muscle extending across the body near the waistline.

Digestion, dissolving food to forms that may enter the blood.

Diphtheria, a throat disease caused by the growth of diphtheria bacteria.

Disinfectant, a substance that will kill disease germs.

Dislocate, to slip the ends of two bones of a joint past each other ; to put out of joint.

Distillation, separating alcohol from a boiling liquid by collecting the steam and cooling it.

Emulsion, a milky liquid in which small drops of fat float in water.

Enamel, the hard coating on the outside of a tooth.

Epidemic, a disease that attacks a large number of people at once.

Epidermis, the thin, outer covering of the skin ; epithelium.

Epiglottis, the lid at the upper end of the windpipe.

Epilepsy, convulsions due to a brain disease.

Epithelium, the cells forming the outer coating of the skin, and the lining of the air tubes and digestive organs.

Esophagus, the tube that conducts food from the throat to the stomach.

Eustachian tube, the air tube leading from the throat to the middle ear.

Excretions, the oxidized substances and waste matters of the body.

Fermentation, changing a liquid containing sugar to carbon dioxide and alcohol.

Filter, a tank of sand used for removing impurities from water.

Focusing, changing the shape of the lens of the eye in order to see clearly.

Formalin, a colorless liquid used for killing bacteria and disease germs.

Fumigation, destroying disease germs by means of a gas.

Funny bone, the nerve on the inner side of the tip of the elbow.

Ganglia, collections of nerve cells in the sympathetic nervous system.

Garbage, waste food and other substances thrown away from the kitchen.

Gas trap, a portion of a waste pipe bent sharply in order to hold water and prevent sewer gas from flowing through the pipe.

Gastric juice, the liquid produced by the stomach to digest food.

Gland, a collection of tubes that remove substances from the blood.

Hemoglobin, the red coloring matter of the blood.

Humerus, the bone in the upper half of the arm.

Hydrogen, a substance that forms a part of every living thing.
Pure hydrogen is a gas, and forms water when it is burned.

Hydrophobia, a disease of the brain usually caught from mad dogs; rabies.

Hygiene, the study of the care of the body.

Hysterics, a mental sickness with great laughing or crying.

Idiot, a grown person who has the mind of a baby.

Immunity, the ability of the body to prevent the growth of disease germs in the flesh or blood.

- Infection**, taking germs of a disease into the body.
- Infectious diseases**, forms of sickness due to the growth of disease germs in the flesh or blood.
- Insanity**, any mental disease in which the sick person is continuously unable to think naturally.
- Intemperance**, satisfying a false appetite.
- Intoxication**, a poisoning by alcohol.
- Iris**, the colored curtain in the front part of the eyeball.
- Lacteals**, the lymph tubes that take digested fat from the intestine.
- Lactic acid**, the sour substance in sour milk.
- Larynx**, the box of cartilage in which the sound of the voice is formed.
- Lens**, the part of the eyeball that forms clear images in the eye.
- Ligaments**, the tough bands of flesh that bind the bones of a joint together.
- Liver**, the gland that manufactures bile.
- Lymph**, the liquid that passes from the blood through the sides of the capillaries to feed the cells of the body.
- Lymphatics**, the fine tubes that conduct lymph toward the heart.
- Maggot**, a young fly in its worm-like stage.
- Malt**, sprouted grain used in making beer.
- Medulla**, the part of the brain next to the spinal cord.
- Microbes**, bacteria.
- Minerals**, the part of the body that is left as ashes when the body is burned.
- Molars**, the double teeth.
- Mold**, microscopic thread-like plants that grow on damp places and often produce a velvet-like covering on food and clothing.
- Morphine**, the narcotic poison in opium.
- Motor nerves**, nerves that carry messages away from the brain or spinal cord.

Mucous membrane, the skin-like lining of the air passages and digestive tube.

Mucus, the substance, like white of egg, formed by mucous membranes.

Muscle, a bundle of cells that produce a motion of some part of the body; lean meat.

Narcotic, a substance that dulls the mind and produces sleep.

Nerve, a thread or string of flesh that carries messages between the brain or the spinal cord and another part of the body.

Nicotine, the principal poisonous substance in tobacco.

Nitrogen, the gas that forms four fifths of the air.

Nucleus, the dark-colored spot seen in most cells.

Opium, the dried juice of a poppy plant. It is a narcotic, and produces sleep.

Organ, a part of the body having a definite work to do.

Osmosis, the mixing of two liquids or gases when separated by a thin sheet or membrane.

Oxidation, the union of oxygen with a substance; burning.

Oxygen, a gas that forms one fifth of the air. It supports oxidation and is the substance taken from the air by the act of breathing.

Pancreas, a gland that produces one of the digestive juices.

Pancreatic juice, the digestive liquid formed by the pancreas.

Panic, a fear that leads a crowd to act in a dangerous manner.

Papillæ, the tiny projections that form lines and patterns on the skin, especially on the palms of the hands.

Paralyzed, unable to move a part of the body.

Paramecium, a microscopic animal composed of a single cell.

Pasteurize, killing bacteria in a substance by a heat just below boiling.

Peptone, digested protein.

Periosteum, the skin-like covering of a bone.

Peristalsis, the motions of the digestive organs by which food is forced down them.

Perspiration, sweat.

Pharynx, the muscular bag forming the back part of the throat.

Physiology, the study of the work of the body.

Plague, a dangerous disease that is spread mostly by rat fleas.

Plasma, the liquid part of the blood ; serum.

Pores, the openings of the sweat glands.

Protein, the substance, like white of egg, that forms the living part of every plant and animal.

Ptomaine (*to'ma-in*), a poison formed by the decay of a substance.

Pupil, the round hole in the iris admitting light into the eye.

Pus, the creamy matter flowing from a wound. It consists mainly of white blood cells killed by disease germs.

Quarantine, preventing the spread of an infectious disease by keeping the sick away from the well.

Rabies, hydrophobia.

Radius, the bone on the thumb side of the arm below the elbow.

Reflex action, the action of the brain or spinal cord made in response to a sensory message.

Reservoir, a very large tank in which water is stored.

Respiration, breathing and the oxidation in the body.

Retina, the inner coating of the eyeball. It contains the nerves of sight.

Saliva, the digestive fluid in the mouth.

Sanatorium, a home in which unhealthy persons are taught how to live healthful lives.

Scarlet fever, an infectious fever in which there is redness of the skin, followed by a peeling of the epidermis.

Scrofula, enlarged glands in the neck.

Sebaceous gland, a gland which produces oil to soften the skin and hair.

Secretion, the substance formed by a gland.

Sensory nerves, the nerves that carry messages to the spinal cord or brain.

Septic tank, a tank in which the solid matters of sewage decay and are liquefied.

Serum, the liquid part of blood.

Sewage, waste water from houses and barns.

Shock, sudden weakness or sickness due to an injury.

Skeleton, a complete set of bones of the body.

Spinal cord, the part of the nervous system that is contained inside the backbone.

Spores, the seed-like particles of dust produced by molds, bacteria, and other plants.

Sputum, thick mucus removed from the air tubes.

Sterilize, to kill bacteria in a substance by heating it.

Sternum, the breastbone.

Stimulant, a substance that acts upon the body like a whip.

Stomach, the bag that receives food after it is swallowed.

Sympathetic system, the part of the nervous system that controls the action of glands and involuntary muscles.

Synovial fluid, the fluid contained in the joints.

Tartar, a brown substance on unbrushed teeth.

Tetanus, lockjaw.

Thermometer, an instrument for measuring warmth.

Thorax, the part of the body surrounded by the ribs.

Tissue, a collection of cells having a special work to do.

Tonsillitis, an infectious soreness of the tonsils.

Tonsils, two masses of flesh growing in the throat.

Toxins, poisons formed by bacteria and disease germs.

Trachea, the air tube leading to the lungs.

Trachoma, an infectious disease of the eyelids.

Triceps, the muscle that bends the elbow.

Tuberculosis, a disease in which white bodies, like pinheads, form in the flesh; consumption.

Ulna, the bone on the little finger side of the forearm.

Urea, a waste substance in the urine.

Urine, the liquid secreted by the kidneys.

Vaccination, protecting the body against smallpox by causing the germs of cowpox to grow in the body.

Ventilation, keeping up a flow of fresh air into a room.

Ventricles, the two cavities in the lower end of the heart.

Vermin, insects and small animals that are troublesome to man.

Villi, the small projections of mucous membrane that take up food from the intestine.

Vocal cords, two bands of flesh by means of which the sounds of the voice are formed.

Wiggler, a young mosquito while it lives in the water.

Yeast, microscopic plants that change sugar to alcohol and carbon dioxide.

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